ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Vol. XLVIII. No. 19.

TABLE OF CONTENTS.

(16 *pages and inset.*)

ENGINEERING NEWS OF THE WEEK..... 373
The Seven-Masted Schooner: In General and in Detail (with two-page plate and other illustrations.) 374
The Cost of Square-Set Timbering..... 377
A Plan for Constructing Dams at Great Depth in Water-Bearing Materials, with Especial Reference to the Bohio Dam (illustrated) 377
The Design of Concrete Piers with Metal Shells (illustrated) 379
A New Method of Cooling Tuyeres 379
The John Fritz Dinner (illustrated)..... 383
Notes from the Engineering Schools..... 385
Comparative Merits of Concrete and Rubble Masonry 385
Coke Manufacture from Compressed Slack..... 385
The Cost of Wire-Rope Hauling in English Coal Mines..... 386
Storm Flows from City Areas and Their Calculation (illustrated)..... 386
EDITORIAL NOTES.. 380
Defects in the Federal Laws Governing Mineral Locations—A New Plan for the Bohio Dam—Caution Needed in Securing Sound Concrete in Concrete-Steel Construction—A Curious List of Minerals.
EDITORIAL:
The Renaissance of the Sailing Vessel 380
LETTERS TO THE EDITOR 382
Some Reasons Why Piles Are Ruined in Driving—More About Scow Measurement—The Value and Significance of Certain Cement Tests—Retarding the Setting of Cement by Continuous Mixing After Wetting—Temperature Stresses in Aluminum Transmission Wires—A Novel Method of Connecting Two Curves with a Tangent (illustrated)—The Electric Smelting of Iron Ore—Notes and Queries.

NO YELLOW FEVER IN HAVANA, CUBA, for a whole year, or at least none reported to the authorities, is the statement made in the September report of Dr. Carlos J. Finlay, Chief Sanitary Officer. This, Dr. Finlay states, cannot be paralleled from the records of the last thirty years at least. No small factor in freeing Havana from yellow fever has been the crusade against mosquitoes, which includes not only efforts to exterminate the insects, but also their exclusion from the rooms of patients suffering with yellow fever. In September, alone, the petroleum corps visited 15,170 houses in its campaign against the mosquito.

IMPROVEMENTS ON THE CHICAGO GREAT WESTern Ry. are being carried out on an extensive scale. The main shops at Oelwein, Ia., which were built only a few years ago, are already being enlarged. The main shop is being lengthened 150 ft., and additions are also being built to the blacksmiths' shop and paint shop, while a new shop for passenger car repairs is being built. The capacity of the power plant and electrical equipment is being almost doubled; the additions include a direct-connected unit of 400-KW. capacity, a 300-HP. water tube boiler, and a fan for mechanical draft. The contract for the new power plant and electrical equipment has been awarded to the Arnold Electric Power Station Co., of Chicago, which installed the original plant. In addition to this, improvements are in progress at numerous points along the line, including double-track work, the reducing of grades and curvature, and the erection of new and permanent bridges in the place of older structures.

THE GREAT OIL STORAGE TANKS for the Southern Pacific R. R. are nearing completion. Five out of the six at Melrose, Cal., have been completed, the total capacity being 14,000,000 gallons. The locomotives running out of Oakland, Cal., now consume 90,000 gallons a day, and they will later require about 135,000 gallons, so that, including two tanks at West Oakland with those at Melrose, the total of 17,430,000 gallons stored will last about five months.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Cincinnati, Hamilton & Dayton Ry. near Oxford, O., on Oct. 29. An eastbound freight had stopped on a siding at Oxford, and was engaged in some switching. The engine coupled to the rear of the train, and the shock of this opened a coupling in the middle of the train, and started the forward portion off down the track. The grade to the eastward helped the runaway cars along, and about a mile out they collided with a westbound express passenger train. The collision wrecked both trains; five persons were killed, it is reported, one of them the engineer of the passenger.

TWO VERY UNUSUAL ACCIDENTS occurred at Niagara Falls last week in connection with engineering works in progress at that place. The Ontario Power Co. is excavating a site for a power station at the water's edge, on the Canadian side, not very far below the Horseshoe Fall. The debris slope of the bank and a portion of the solid rock underneath is being broken away, and to accomplish this heavy blasts are discharged. In order that there may be no necessity of handling the rock, powder is used for blasting. The river at this point is about 2,000 ft. wide. Immediately opposite the power-house site is Goat Island, a portion of the New York State Reservation. At noon on Oct. 28, an exceedingly heavy blast made up of 2,500 lbs. of black and granulated powder and between 200 and 300 lbs. of dynamite was arranged, and warning was sent from the Canadian to the New York State Reservation officials to keep people back from the face of the cliff until the blast was discharged. At 12.15 o'clock the upheaval took place. A tremendous mass of rock and dirt was hurled skyward, a vast portion of it falling into the river, but another portion ascended high above the river bank and fell upon Goat Island. One big rock 32 ins. long, about 14 ins. wide and 9 ins. thick flew 500 ft. back from the Goat Island bank and fell upon Patrick Moakler and Patrick Kelley, two old employees of the state reservation. Moakler was knocked unconscious, while both of Kelley's legs were cut off, one being found 139 ft. from his body and the other 60 ft. away. Both men died in the hospital. Previous to striking the men, the rock severed a big branch from a tree, and after striking them it dug a hole 5 ft. deep in the earth and then rolled against trees, where it stopped. The stone weighed between 225 and 250 lbs. The coroner's verdict charges the Ontario Power Co. with negligence, and damage suits will follow. The second accident cost four lives, a party of workmen having been overcome with sulphuretted hydrogen gas in the tunnel trunk sewer extension. The tunnel trunk sewer extension will be about 3,000 ft. long. Of this distance the contractor, James D. Casey, of Rochester, N. Y., has driven 1,300 ft. The sewer is 7 × 9 ft. in size and is being built at a depth of about 45 ft. below the surface. The men had been working in the heading at the bottom of the 24th St. shaft, when George Rhodes was overcome by the gas. His companions started to take him to the surface, when he plunged out of the bucket and fell 30 ft. into the tunnel. A rescue party was arranged as soon as possible. Two men died on the spot, and two others soon after in the hospital. Other men who were overcome will recover. This sewer extension has given no end of trouble. The inflow of water has been very large. A consultation of engineers was held, and the Niagara Falls Power Co. offered the city the service of its engineers to aid City Engineer McCulloh, should he wish to advise with them. After consideration of the question, the board of works authorized the city engineer to raise the grade of the tunnel 10 ft. in an effort to escape the water-bearing rock. The water met with is of a sulphurous nature, and is found in all the rock excavation at Niagara.

TWO LOCOMOTIVE BOILER EXPLOSIONS occurred within the last two weeks. On Oct. 24, when near Kansas City, Mo., the engine of a through freight on the Chicago & Alton Ry. blew up and wrecked the larger part of the train. The engineer and fireman were killed.——A freight engine on the Baltimore & Ohio Ry. exploded on Nov. 2 near Baltimore, Md. Three men of the train crew were killed.

AN ELLITHORPE ELEVATOR AIR-CUSHION TEST was made Oct. 23 in the Patent Office Building, Washington, D. C. The elevator car dropped 50 ft. without injury to the eggs or the monkey that it carried.

COAST DEFENSE AT NIGHT is to be made a subject of more careful study by a board of U. S. engineers, for the recent naval and army manœuvres developed the fact that most searchlights were so improperly placed that they furnished excellent guides to the hostile fleet. Moreover they require better defense, as they could have been readily destroyed by rapid-fire guns.

A LARGE NAVAL COALING WHARF for governmental use is being built at Seattle, Wash. The wharf, including trestle approach, is to be a quarter of a mile long, and will cost over a quarter of a million dollars. 5,000 piles and 3,500,000 ft. B. M. of fir will be used. When completed warships may take on coal at the rate of 200 tons per hour.

OUR SEACOAST DEFENCES are half finished, according to Brig. Gen. Gillespie's annual report, and 25 of the principal harbors have enough heavy guns mounted to secure an effective resistance to naval attack. General Gillespie recommends an appropriation of $7,425,000 for the coming year. The coast defences when completed will have cost $50,000,000.

THE SUBMARINE BOAT "PROTECTOR" was launched Nov. 1 at Bridgeport, Conn., in the presence of Capt. W. H. Taylor, representing the Board of Construction of the U. S. Navy, and of representatives of other governments. The "Protector" is 60 ft. long and has a 11-ft. beam and 65-ton displacement when submerged. She is equipped with a running gear to travel on the sea bottom. Gasoline, when awash, and electricity, when submerged, furnish the motive power.

THE BRITISH PACIFIC CABLE, connecting Vancouver, B. C. (Canada), with Brisbane, Queensland (Australia), was completed during the past week. The cable extends from Bamfield Creek, Vancouver Isl., to Fanning Island, in the middle of the Pacific; thence it goes, in several sections, to Norfolk Isl., just north of New Zealand, and connects here to New Zealand and to Australia, at Brisbane. The first section of this cable is the longest continuous submarine telegraph line in the world. The cable will be opened for public use in a few weeks.

A STEEL COFFERDAM is being built in the Mississippi River at St. Louis, Mo., for the construction of the foundations of the new power station of the Union Electric Light & Power Co., the east wall of which will extend about 100 ft. into the river at high water. The cofferdam is 40 × 360 ft., and is 50 ft. deep to bedrock. It will be entirely of steel, the sheeting being of interlocked Z-bars, and no wood being used even for the interior bracing. The steel work is furnished by the Interlocking Channel Bar Co., 1200 Tribune Building, Chicago. The power station will cost about $1,000,000, and it is said that the plant will be one of the largest of its kind in the world. The power company is doing its own construction work, and Mr. W. S. Ludington is Resident Engineer.

CIVIL SERVICE EXAMINATIONS for candidates for the positions of electrical engineers, assistant electrical engineer, instructors in iron molding, assistant civil engineer, leveler, and bacteriologist for state hospitals will be held at Albany, N. Y., on Nov. 29. Persons desiring to enter these examinations must file applications in the office of the State Civil Service Commission at Albany, N. Y., before Nov. 24. Application blanks and information regarding salaries and requirements may be had by addressing the Chief Examiner, Charles S. Fowler.

A LIQUIDATOR for the New Orleans Water-Works Co. has been appointed by the Governor of Louisiana to close up the affairs of the company. The charter of the company has been declared forfeited by the State Supreme Court and the Federal courts have refused to intervene. The old company has transferred its property to the New Orleans Water Supply Co., and the bondholders of the old company have secured the appointment of a receiver and have brought proceedings to foreclose their mortgage. The State Liquidator, Mr. John W. Castles, of New Orleans, has been made one of the defendants in the foreclosure suit, which is pending in the U. S. Circuit Court. The forfeiture of the company's charter was largely due to its failure to comply with the charter requirements regarding the water supply and the rates charged therefor. The city has been engaged for some time in preliminary work for an ample supply of good water, the provision of which will require purification works and other improvements.

A BOOK OF CITY BENCH MARKS in Hartford, Conn., has been prepared by Mr. Frederick L. Ford, City Engineer of Hartford, and distributed among the civil engineers in that city. About 1,400 bench marks are included, arranged by streets, like the following:

WINTHROP STREET.

Pleasant Street—El. **59.655.** Top of rivet head in iron fence fastened to S. W. cor. brick building on N. E. cor Winthrop and Pleasant Streets—No. 14.

Mr. Ford describes the work in question as follows:

This book represents the labors of two seasons of very careful leveling work, great pains being taken to produce a most reliable system of benches covering the entire city. In executing the field work an 18-in. Buff & Berger Y-level and a Philadelphia rod with patent rolling angle target were used. The city was divided into sections and two sets of levels run around the limits of each, one in each direction, the levelman and rodman changing places in each second circuit, to eliminate as far as possible personal errors. After each main circuit of elevations was determined by careful adjustment, benches were established on all intermediate streets by carefully checking the elevations with those of the main circuit as often as convenient. As it proved to be a difficult matter to find permanent and convenient objects to establish benches on in the outskirts of the city, most of the buildings being wooden structures, bench plates were prepared (see enclosed sample) of cheap composition material and screwed securely to the base board of houses where benches were to be located. Many of these plates were put on corners of houses standing at street intersections so they are available from either street. As some of these benches will be destroyed by the removal of buildings upon which they are located and as new ones will be established in their places and on newly opened streets, engineers receiving a copy of this book were advised to compare their book with the "Official Copy" at the city engineer's office at least once a year and make the necessary corrections on the blank pages in the back of each book prepared especially for this purpose. Every engineer in the vicinity of Hartford has been presented with a copy by the City Engineer and they will no doubt prove of great benefit to all and at the same reduce all leveling work in Hartford to a uniform basis and avoid the necessity of ever using assumed elevations to work from.

The sample bench plate, mentioned above, is approximately 4 ins. wide and 2½ ins. high, with raised lettering ⅝-in. high and blanks for the corresponding figures. Extending across the center are the words "City Bench," and above and below are the abbreviations "No." and "El.," respectively.

THE SEVEN-MASTED SCHOONER—IN GENERAL AND IN DETAIL.

By Henry P. Jones, M. E.*
(With two-page plate.)

If records may be relied upon, shipbuilding in America dates back to 1607, when the "Virginia" was built and launched near the mouth of the Kennebec River. It is also recorded that about 1714 there was launched at Gloucester, Mass., a small two masted craft with fore and aft rig to which the term "schooner" was first applied.

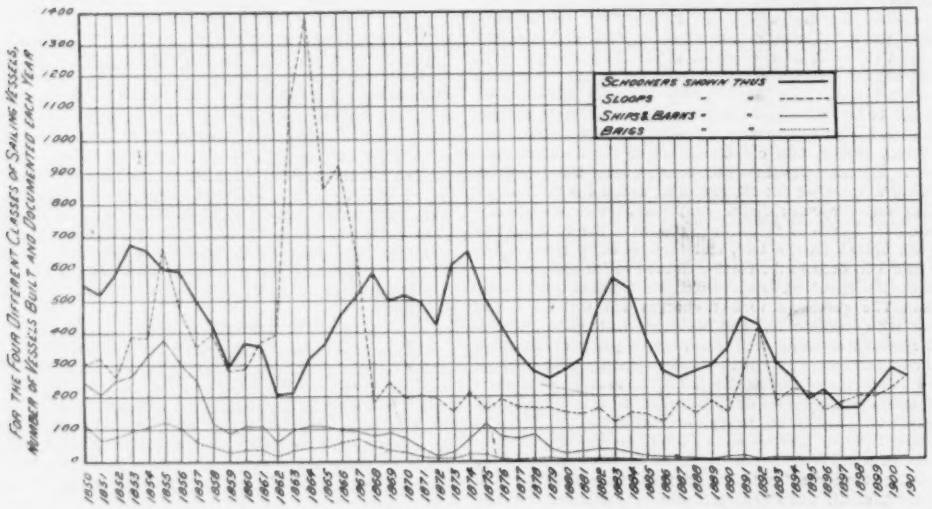


FIG. 1. DIAGRAM SHOWING THE NUMBER OF SAILING VESSELS OF THE FOUR PRINCIPAL TYPES OF RIG, BUILT AND DOCUMENTED EACH YEAR IN THE UNITED STATES, FROM 1850 TO 1901.

However, it is the intention of the writer to deal with the latest example of this type of vessel, rather than with its historical development; but before entering upon a detailed description of the seven masted schooner launched at Fore River on July 10 last, it may be of interest to consider briefly, and with as little statistical reference as possible, the present status of the sailing vessel in the American merchant marine.

Not only will such consideration serve to indicate the present tendency and future possibilities of vessels of this class, but it may also convey a clearer understanding of the courage and progressiveness of American shipowners, which, backed by the inherent skill of our workmen, and modern plant equipment at their command, promises much for the augmentation of American built tonnage.

The total documented tonnage of the United States, as recorded on June 30, 1901, has been exceeded only once in our country's history, namely in 1861, and of this total tonnage, 65% represented wooden vessels, and 45% comprised the various classes of sailing vessels. Of the remaining, or "steam" tonnage, 56% was of iron or steel, while in case of sailing vessels only 10% was so constructed.

In taking up the question of the modern sailing vessel, it is interesting to note what might be called the "survival of the fittest" as regards certain types or "rigs." The accompanying diagram, Fig. 1, covering the period from 1850 to 1902, has been prepared with a view of illustrating the persistent, if somewhat erratic, course of the schooner rig, as well as the decline of the "square rigged" type of sailing vessel.

This latter rig promises, in time, to become a matter of history, excepting, perhaps, in France, where square rigged sailing vessels receive subsidies in excess of steamers.

On June 30, 1901, there were 371 square rigged American vessels, comprising 104 ships, 157 barks, 80 barkentines and 30 brigs or brigantines—a total gross tonnage of 398,841, of which only 16% was of iron or steel.

As regards the oldest wooden vessel of each of these classes, recorded as still documented, the ship "Dashing Wave," built in 1853; the bark "Canton," built in 1835; the barkentine "Fremont," built in 1850; and the brig "Tanner," built in 1855, appear to hold the records.

The oldest iron vessels for the same classes seem modern in comparison, for we have the ship "Star of Italy," built in 1877; the bark "Himalaya," built in 1863; and the barkentine "Ruth," built in 1860.

The evidences of thoroughness upon the part of our early constructors should not be passed over without comment, for we find that during the year 1900 the wooden bark "Kathleen," built in 1844, placed 5,022 miles to her credit, and the wooden bark "Swallow," built in 1856, 7,350 miles. In the same year, 1900, there were 537 American wooden schooners of a total gross tonnage of 231,298, which made a total mileage of 2,161,140 miles. Of these the "Eastern Light," built in 1847, and the "Mary Ellen," built in 1855, were still carrying on the Canada-Newfoundland trade.

Referring to the question of schooner rigs in particular, it must be borne in mind that the above-noted diagram is based upon the number of vessels built each year and not upon their aggregate gross tonnage.

As a matter of fact, the tonnage of the schooner has increased notably in recent years. For example, there were built and documented upon the United States seaboard during the year ending June 30, 1901, 22 schooners of a total gross tonnage of 40,273, or an average of 1,830 tons. Ten of these ranked among the 29 largest schooners in existence, two having six masts, seven having five masts and one having four.

As to the cause of this tendency toward large sailing vessels of the schooner type, so well exemplified by the above-noted 22 instances, we have only to consider the fact that there is annually a large amount of imperishable bulk freight awaiting coastwise or foreign transportation at comparatively low rates, and that the large schooner, on account of economies which will become evident, can profitably extend such rates and make deliveries within acceptable time.

The principal dimensions of the seven masted schooner "Thomas W. Lawson" are as follows:

Length, knighthead to taffrail	403 ft. 4 ins.
Length on water line (draft, 26 ft. 6 ins.)	368 " 0 "
Beam, molded	50 " 0 "
Depth, molded	35 " 2 "
Gross tonnage	5,218 tons.
Under deck tonnage	5,006 "
Net tonnage	4,914 "
Length of steel lower masts	135 ft.
Diameter, outside, of steel lower masts	32 ins.
Length of pine topmasts	58 ft.
Height, topmast truck above deck	151 "
Length of steel bowsprit	85 "
Length of steel bowsprit, outboard	69 "
Sail area	43,000 sq. ft.
Weight of stockless anchors, each	10,000 lbs.
Cable, 220 fathoms of stud chain	2¾ ins.

In general, the workmanship upon this vessel, which was built under special survey of the Bureau Veritas and American Bureau of Shipping, to classify A1 for 20 years, is of the most thorough character, particular care having been taken to insure fair lines, smooth surfaces and watertightness.

The work of laying the bar keel was commenced Nov. 1, 1901, it being of steel, 12 ins. by 3½ ins.,

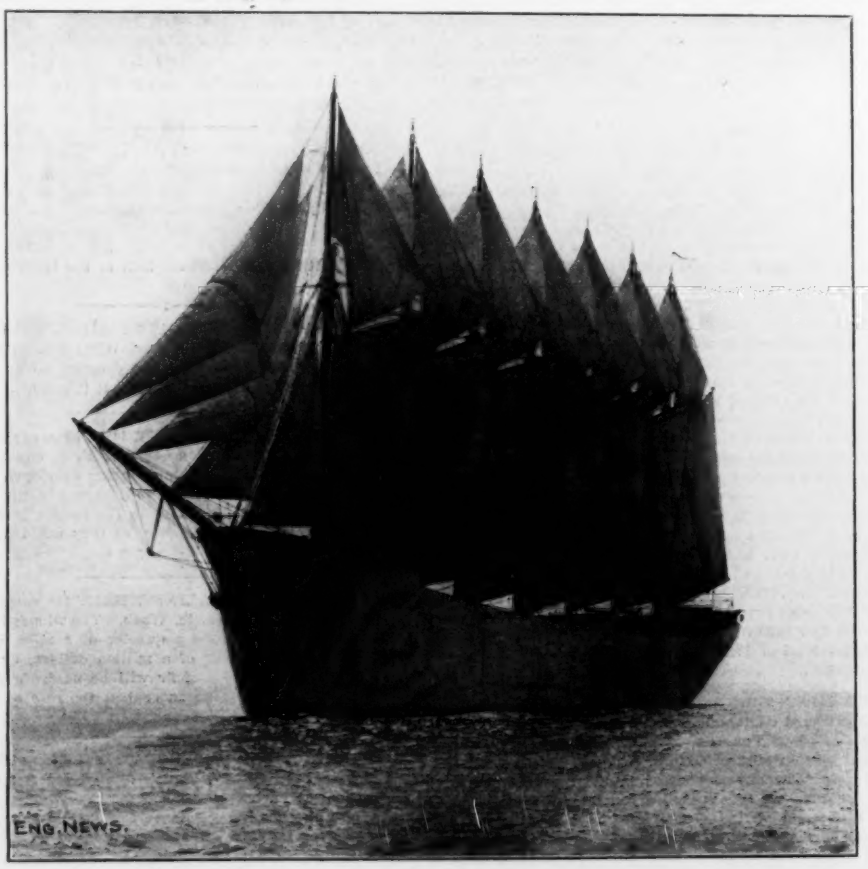


FIG. 2. THE SEVEN MASTED SCHOONER "THOS. W. LAWSON" UNDER WAY AT SEA.
The Fore River Ship & Engine Co., Quincy, Mass., Builders; Capt. J. G. Crowley, Managing Owner; B. B. Crowninshield, Naval Architect.

*Quincy, Mass.

worked in long lengths, properly scarfed and connected to stem and stern post forgings of same section as bar keel.

A cellular double bottom is worked as far forward and aft as possible, a continuous vertical keel or center plate connecting the inner and outer bottom. Two longitudinals, or intercostals, from forecastle to poop, suitably stanchioned and capped, and a light open rail 2 ft. 6 ins. high is provided for forecastle and poop. Chain plates of suitable size are worked inside the rail.

The steel lower masts are built with flush joints and are suitably stiffened throughout their length by longitudinal channels with webs curved to fit

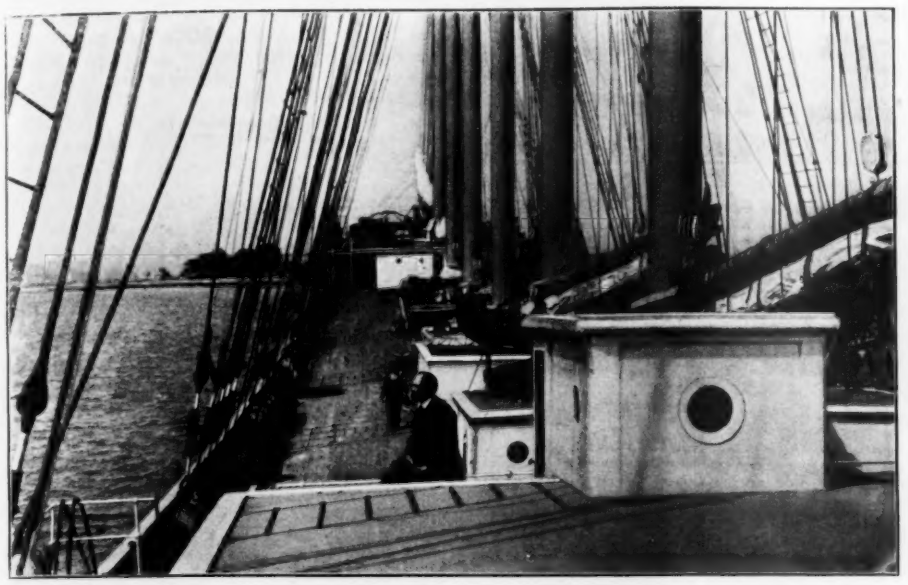


FIG. 3. VIEW ALONG THE DECK OF THE "THOS. W. LAWSON."

are also worked in between the inner and outer bottom, suitable manholes, limber and air holes being provided, making possible a thorough inspection of the double bottom.

The shell plating is of the "in and out" or joggle plate system, the sheer strake being doubled for two-thirds the length amidship. Bilge keels are fitted for one-half the length amidship. Three tiers of deck beams, of channel section, are fitted on alternate frames throughout the vessel, and a thoroughly stiffened collision bulkhead is located at a proper distance from the stem.

Six main hatchways are provided in the upper deck, sizes and locations being as shown on plan. The coamings of these hatches rise 30 ins. above the deck plating, and corresponding hatches occur in the second and lower decks.

The upper deck, forecastle deck, and poop deck are covered with 4 × 3½-in. wood planking secured to the steel deck with galvanized iron bolts, the whole being thoroughly doweled and calked.

A solid plate rail 4 ft. 3 ins. high is worked the interior radius. The bowsprit is of similar construction.

The standing rigging and certain running rigging for lower sails is of the best quality of wire rope, the remainder being of best manila. Iron work and fittings for spars are of best hammered scrap iron, lugs being worked from solid stock, no jump welds being used. Galvanizing is resorted to where advisable.

The living and machinery spaces include four deck houses of steel, worked in panels. The forecastle is fitted with bunks for crew and all necessary plumbing.

The galley is fitted with a steel range and the necessary equipment of lockers, shelves, tables, etc.

Officers' quarters include a main cabin, pantry, large captain's cabin, staterooms, bath, etc., all finished in hard wood and presenting an exceptionally neat appearance. Living spaces are all provided with radiators, supplied with steam from the boilers, and the vessel is lighted by electricity throughout, and is also provided with a complete telephone system.

In addition to two 200-gallon galvanized iron tanks, there are three water tanks holding a total of 10,000 gallons, and one galvanized iron tank of 500 gallons capacity.

The forward deck house contains a 9-in. × 10-in. double-cylinder ship engine, with drum shaft extending outside of house on either side. Five 8-in. × 8-in. hoisting engines are located on the deck, as shown in plan, and one of similar size, with extended drum shaft, in the deck house aft. The boiler equipment consists of two vertical boilers 56 ins. diameter by 90 ins. high, one located in the forward house, the other in the house aft. They are designed for a working pressure of 100 lbs. per sq. in.

The condensing system used in connection with the engines includes two coil condensers in cast-iron casings, each attached to a condenser tank of 300 gallons capacity.

Two donkey pumps, 6-in. × 4-in. × 6-in., duplex, are provided for purposes of circulation, washing down decks and fire service, and there are also two main ship pumps, each 12-in. × 12-in., direct-acting. Two deep chamber hand pumps are also furnished.

The windlass controlling the 2¾-in. chain cables may be operated either by the forward donkey engine or by hand, and is fitted with the necessary locking gear, friction bands, etc. A capstan and winch head is also installed in connection with the windlass.

The steering gear, shown in Fig. 4, is of an approved type, fitted with mahogany wheel, and easily controls the rudder, which is of cast-steel frame, single-plated, having a 10-in. stock.

Having thus described, in such detail as space will permit, the constructive features and equipment of this notable addition to our merchant marine, it may be instructive briefly to consider the attendant economic features. Far from being a sensational departure in the way of sailing craft, it is rather the latest development of seafaring enterprise backed by the years of experience which brought with them success.

That Capt. J. G. Crowley, the managing owner of the "Lawson," is also managing owner of the six masted wooden schooner "Geo. W. Wells," 2,970 gross tons, not to mention other vessels, is to those familiar with coastwise trade a sufficient guarantee that the seven masted steel schooner is not a venture, barring, of course, the customary perils of the sea. The profits which large schooners have heretofore netted their owners have already attracted attention. Even with sharp competition in freight rates the returns have been excellent, 25% upon the investment being considered moderate and 35% to 40% somewhat better.

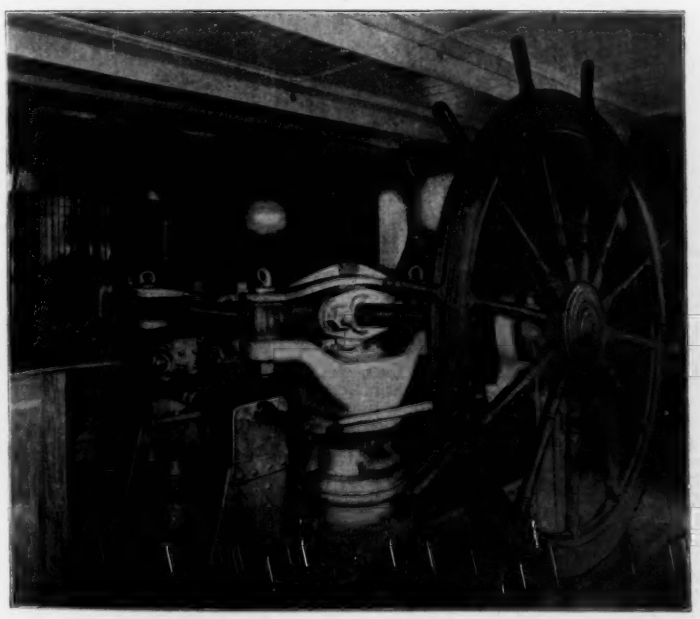


FIG. 4. VIEW IN THE WHEEL HOUSE.

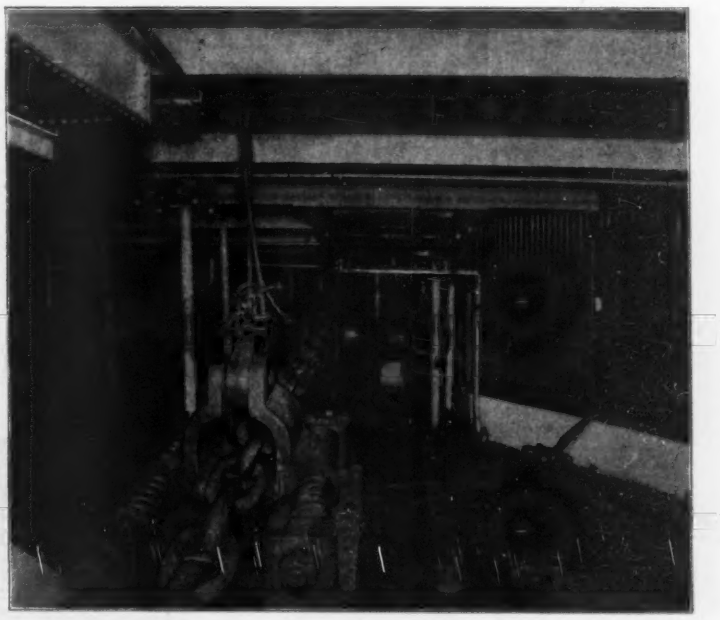


FIG. 5. INTERIOR OF DECK HOUSE, SHOWING CHAIN CABLES.

In case of the large wooden schooners, unless one has actually looked upon the masses of built-up timber which enter into their construction, it is difficult to realize the sacrifice of interior space be gained in the steel vessel. While first cost is increased, it is not to be compared with increased earning capacity due to larger cargoes.

The "Lawson" can carry a cargo of about 8,000 men, and as a comparison between the sch and square rigged type of sailing vessel, it ported that the five masted full rigged "Preussen," recently launched abroad, and

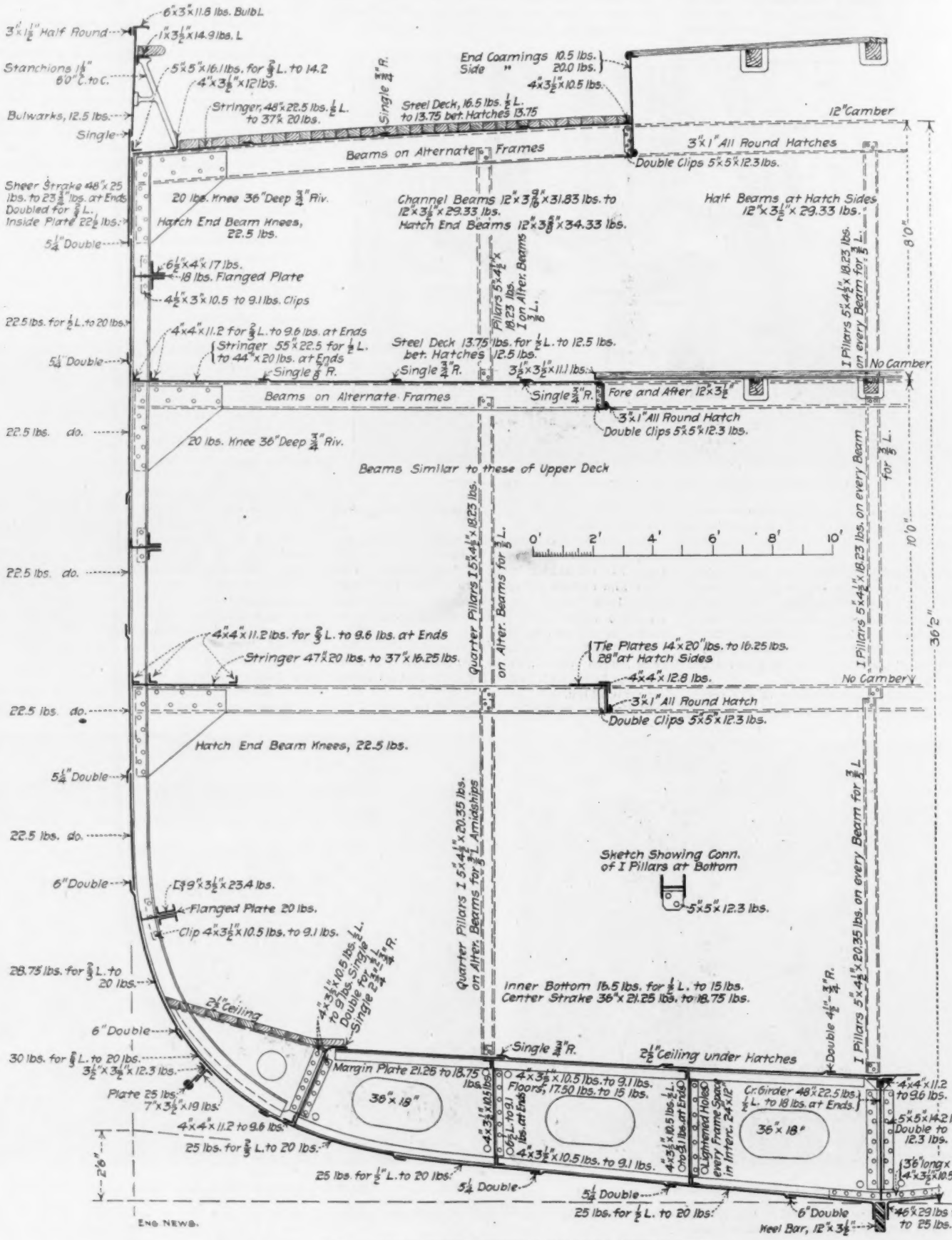

6"x3"x11.8 lbs. Bulb L.
3"x1/2" Half Round
1"x3 1/2"x14.9 lbs. L
Stanchions 1/2" 6'0" C. to C.
5"x5"x16.1 lbs. for 3/8 L. to 14.2
4"x3 1/2"x12 lbs.
Bulwarks, 12.5 lbs.
Single
Stringer, 48"x22.5 lbs. 1/2 L. to 37"x 20 lbs.
Single 1" R.
Steel Deck, 16.5 lbs. 1/2 L. to 13.75 bet. Hatches 13.75
End Coamings 10.5 lbs.
Side " 20.0 lbs.
4"x3 1/2"x10.5 lbs.
12" Camber
3"x1" All Round Hatches
Double Clips 5"x5"x12.3 lbs.
Beams on Alternate Frames
Sheer Strake 48"x25 lbs. to 23 3/4" lbs. at Ends Doubled for 3/8 L., Inside Plate 22 1/2 lbs.
5 1/4" Double
20 lbs. Knee 36" Deep 3/4" Riv.
Hatch End Beam Knees, 22.5 lbs.
Channel Beams 12"x3 9/16"x31.83 lbs. to 12"x3 1/2"x29.33 lbs.
Hatch End Beams 12"x3 5/8"x34.33 lbs.
Half Beams at Hatch Sides 12"x3 1/2"x29.33 lbs.
6 1/2"x4"x17 lbs.
18 lbs. Flanged Plate
4 1/2"x3"x10.5 to 9.1 lbs. Clips
22.5 lbs. for 1/2 L. to 20 lbs.
4"x4"x11.2 for 3/8 L. to 9.6 lbs. at Ends
Stringer 55"x22.5 for 1/2 L. to 44"x20 lbs. at Ends
Single 5/8 R.
Steel Deck 13.75 lbs. for 1/2 L. to 12.5 lbs. bet. Hatches 12.5 lbs.
Single 3/4" R.
Pillars 5"x4 1/2"x 18.23 lbs. on Alter. Beams for 3/8 L.
3 1/2"x3 1/2"x11.1 lbs.
I Pillars 5"x4 1/2"x 18.23 lbs. on every Beam for 3/8 L.
8'0"
No Camber
Fore and After 12"x3 1/2"
3"x1" All Round Hatch
Double Clips 5"x5"x12.3 lbs.
Beams Similar to these of Upper Deck
0' 2' 4' 6' 8' 10'
10'0"
Quarter Pillars 1 5"x4 1/2"x 18.23 lbs. on Alter. Beams for 3/8 L.
4"x4"x11.2 lbs. for 3/8 L. to 9.6 lbs. at Ends
Stringer 47"x20 lbs. to 37"x 16.25 lbs.
Tie Plates 14"x20" lbs. to 16.25 lbs. 28" at Hatch Sides
4"x4"x 12.8 lbs.
36'2"
Hatch End Beam Knees, 22.5 lbs.
Sketch Showing Conn. of I Pillars at Bottom
5"x5"x 12.3 lbs.
Quarter Pillars 1 5"x4 1/2"x 20.35 lbs. on Alter. Beams for 3/8 L. Amidships
I Pillars 5"x4 1/2"x 20.35 lbs. on every Beam for 3/8 L.
6"Double
L 9"x3 1/2"x 23.4 lbs.
Flanged Plate 20 lbs.
Clip 4"x3 1/2"x 10.5 lbs. to 9.1 lbs.
28.75 lbs. for 3/8 L. to 20 lbs.
2 1/2" Ceiling
4"x3 1/2"x10.5 lbs. to 9 lbs. Single Double for 3/8 L. Single 2 3/4" R.
Inner Bottom 16.5 lbs. for 1/2 L. to 15 lbs.
Center Strake 36"x 21.25 lbs. to 18.75 lbs.
Double 4 1/2" - 3/4" R.
30 lbs. for 3/8 L. to 20 lbs.
3 1/2"x3 1/2"x 12.3 lbs.
Plate 25 lbs.
7"x3 1/2"x19 lbs.
Margin Plate 21.25 to 18.75 lbs.
36"x 19"
4"x3 1/2"x10.5 lbs. to 9.1 lbs. Floors, 17.50 lbs. to 15 lbs.
4"x3 1/2"x10.5 lbs. 1/2 L. to 9 lbs. at Ends
Lightened Holes every Frame Space in Interc. 2'4"x2
Cr. Girder 48"x22.5 lbs. 1/2 L. to 18 lbs. at Ends
36"x 18"
4"x4"x11.2 to 9.6 lbs.
5"x5"x14.2 lbs. Double to 12.3 lbs.
36" long x 4"x3 1/2"x10.5 lbs.
25 lbs. for 3/8 L. to 20 lbs.
25 lbs. for 1/2 L. to 20 lbs.
5 1/4 Double
46"x29 lbs for 1/2 L. to 25 lbs.
6" Double Keel Bar, 12"x3 1/2"
ENG NEWS.

FIG. 8. HALF CROSS-SECTION OF HULL AMIDSHIPS.

which, with steel construction, is so largely avoided. Thus, the available cargo capacity of the "Lawson" is a maximum for its dimensions, while with the wooden schooner it is a minimum, to say nothing of the additional strength that may

tons of coal. The entire crew consists of only 16 men. The mechanical equipment which makes it possible to handle the vessel with so few men, also renders the handling of cargo an easy matter.

In connection with the above-noted number of

to be the largest sailing vessel in the world, though of the same cargo capacity as the "Lawson," requires a crew of about 40 men.

As regards the operating ex[illegible]ense of the "Lawson" as compared with that of a steamer of the

same or even of much smaller cargo capacity, it is hardly necessary to point out the advantage possessed by the schooner. Not only is the crew of the steamer from two to four times that of the schooner, but the most important expense, that of fuel, must be considered. It is true that the schooner is dependent upon winds that may vary, while the steamer is independent; but on the other hand, it must be borne in mind that the average speed of the freight steamer is fixed at, say, 10 or 12 knots, while the "Lawson," with a fair wind, can easily exceed that speed. Under favorable conditions, the "Lawson's" time will not be to her disadvantage, and it is probable that her average run will be much nearer that of the steamer than we are in the habit of associating with the performance of a sailing vessel.

Referring to the permanency of the investment, it has already been pointed out that the "Lawson" will Class A1 for 20 years. All possible precautions have been taken by her builders, the Fore River Ship & Engine Company, to prevent deterioration of the hull, particularly the inner bottom. With profits approaching those indicated, and insurance rates high, say 8%, it is easy to understand why owners who control a number of such vessels prefer to carry their own insurance. This is, however, usually optional with the shareholders, who may, if they so desire, insure their own interest.

With the above facts before us, it seems assured that the class of steel vessels of which the "Thomas W. Lawson" is at present the representative will soon become an important addition, not only to our coastwise, but also to our foreign transportation facilities. These thoroughly equipped steel schooners may have more than seven masts, they may have less, but they will probably follow the same type, and will fill a demand in the industry of transportation which may lead to the exporting of certain commodities for which a ready market could be found abroad provided that rates could be secured which would bear a smaller ratio to the intrinsic value of the cargo.

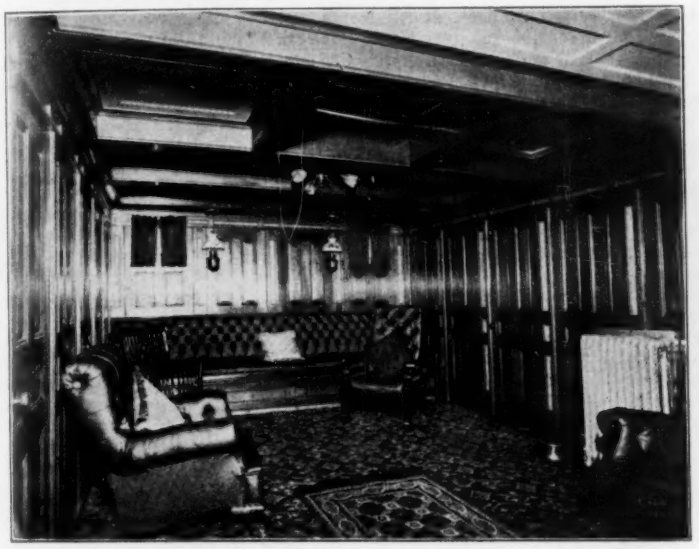


FIG. 6. INTERIOR OF CABIN.

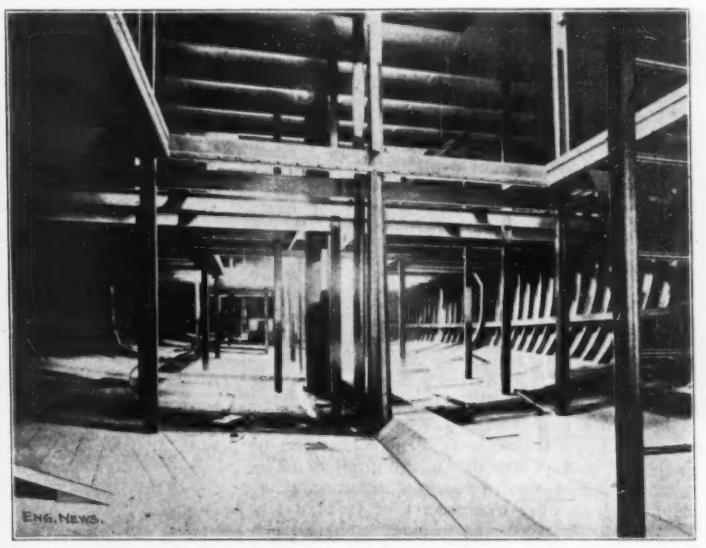


FIG. 7. VIEW IN THE HOLD.

THE COST OF SQUARE-SET TIMBERING.

Technical papers so seldom contain detailed cost data that it is refreshing when a paper comes to hand that does. At the recent meeting of the Canadian Mining Institute, Mr. Bernard McDonald presented a paper on "Mine Timbering by the Square Set System at Rossland, B. C.," which contains data of interest, not only to those engaged in mining, but to those also who have anything to do with the dollars and cents part of timber structures in general.

The square-set system is a rectangular skeleton framework of posts, sills, girts, braces (diagonal) and caps of comparatively short lengths mortised together; and where the ore extracted exceeds a width of 15 ft., it has been found to be the only effective system of timbering. Mr. Philip Deidesheimer, while superintendent of the Ophir mine on the Comstock Lode, in 1860, is said to have invented the system; at any rate, he appears to have been the first to use it in the United States.* Mr. McDonald speaks of the system as "distributing local strains after the manner of a truss," but this is not exactly true, as there are usually no diagonal braces such as any truss system requires, while diagonals when used are more in the nature of the sway bracing common in pile and bent trestles.

Round, peeled and seasoned logs, or sawed timbers, ranging from 8 to 20 ins. in diameter, may be used, but for the Rossland mines round 16-in. sticks, 16 ft. 6 ins. long, are imported from the State of Washington. After a haul on flat cars of 45 to 75 miles, each car holding 60 logs, they are delivered at the framing shed at the mine at a cost of $1.20 per log.

A "square set" comprising one post, one cap, and a girt or brace, requires 18½ ft. of logs, which at 8 cts. a foot, is nearly $1.50 a set delivered at the framing shed. The cost of framing the pieces of a "set" is about $0.55 when framed by hand labor, carpenters receiving $3.50 for 9 hrs.

	For material.	For labor.
One post costs	$0.65	$0.167
" cap "	.43	.219
" girt "	.40	.187
Total	$1.48	$0.573

The cost per set in place is:

Material	$1.48
Labor framing	.57
Lowering into mine say	.10
Delivering to place, say	.10
Labor erecting	1.50
Incidental material, wedges, nails, etc.	.10
Sill floor, averaged over 11 sets	.15
Total, per set, say	$4.00

[Segregating the labor items we have a cost of $2.27 per set of 18½ ft., or about 12 cts. per lineal foot, so that if the timbers were square 12 × 12-in. sticks, the labor cost would be about $10 per M. ft. B. M., which is not excessive considering the high rate of wages.—Ed.]

When framed by machine saws the cost of framing a set, including cost of power, is about 30 cts., as compared with 55 cts. by hand. Since the average space to be excavated for each "set" is 5.3 ft. wide × 5 ft. long × 9 ft. high = 240 cu. ft., and since the Rossland ores yield 200 lbs. per cu. ft. in place, the cost of timbering is 17 cts. per ton of ore mined. When owing to wall pressure or imperfect erection of the sets, "jack-knifing" of the sets results, a cave-in may be prevented by cribbing the skeleton framework with logs, or by filling with waste rock or earth.

*See Monograph IV. of the United States Geological Survey, "Comstock Mining and Miners."

A PLAN FOR CONSTRUCTING DAMS AT GREAT DEPTH IN WATER BEARING MATERIAL, WITH ESPECIAL REFERENCE TO THE BOHIO DAM.

By J. T. Ford,* M. Inst. C. E.

For the past 15 years, first with the Nicaragua Canal Co., and later with the Colombian Government as consulting engineer, I have been more or less connected with, and always deeply interested in the Isthmian canal problem. I have always felt that I have formed my judgment as to the choice of routes from an unusually impartial standpoint of professional interest in the correct solution of the greatest engineering work of our times, and with a very complete knowledge of both routes by personal experience on the ground.

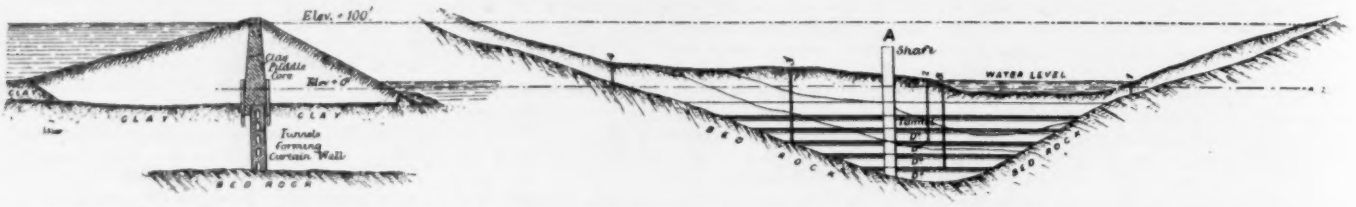
The controlling feature, in my opinion, at both places, has always been the great dam or dams that must be built under all or any of the locations proposed. None of the plans so far submitted have ever satisfied me as presenting the necessary degree of safety that should be obtained on so great a work; and in this respect alone have I thought that the Nicaragua route possessed a slight, but *very* slight, advantage over Panama. In all other respects I have for a long time been a Panama advocate of very decided views, although somewhat worried over the great Bohio dam.

I felt confident, however, that some better solution would be given to the details of the construction than had been proposed so far in the general discussion on Isthmian canals. But when the plans of the French technical commission were published, and these were followed by those of the American Isthmian canal commission, I saw that nothing really satisfactory had been developed. The former proposed a plain earth dam with puddle core wall resting on admittedly treacherous foundation material of unknown depth in some places; while the latter, discarding such a proposition altogether, and finding the deepest bed rock at 128 ft. below water surface in the river, proposes the unprecedented scheme of sinking separate caissons down to that depth in such a climate and in the bed of such a stream as the Chagres. This latter plan necessarily involved control of the fearful floods to which it is frequently subject—for some years perhaps—while the cofferdams are in place, by a series of inferior auxiliary dams, which, if possible at all under such conditions, would only prove the unnecessary character of the more expensive main structure proposed by the commission. And this main structure when complete would consist, not of a continuous core wall completely sealing the bed rock section of the valley, but rather of a series of disconnected columns of masonry built in caissons impossible of such perfect union, either

*Attache and Consulting Engineer, Colombian Legation, Washington, D. C.

along the bottom or at the joints of the sections as would warrant the enormous total estimated cost of $8,106,114. It would have but little transverse strength, and would probably allow just as much seepage to pass through as a well-constructed plain puddle dam.

Taking more or less of this view of the commission's dam, Mr. Geo. S. Morison, himself a member of the commission, presented to the American Society of Civil Engineers, in January



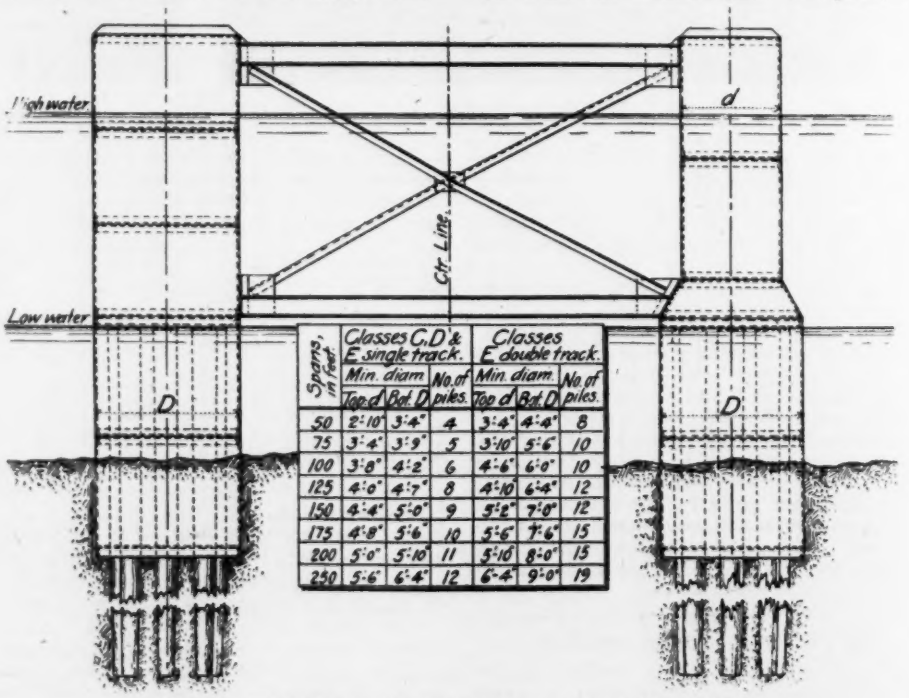
LONGITUDINAL AND CROSS-SECTIONS OF BOHIO DAM FOR PANAMA CANAL, SHOWING METHOD OF CONSTRUCTION PROPOSED BY J. T. FORD, M. INST. C. E.

last, a paper describing the type of dam which he prefers; namely, one very similar to the great Wachusett dam now under construction near Boston. I took part in this discussion (see proceedings of the society for May, 1902), and brought forward the so far novel plans which I here describe, and ask you to discuss in your valuable paper.

The discussion by other members of the American Society of Civil Engineers, notably that of Mr. F. P. Stearns, the engineer of the Wachusett dam above mentioned, makes one of the most interesting documents on the subject of earth dam construction anywhere to be found. But if carefully analyzed, especially in the experiments described as to the filtration of water through various earths and some other points brought forward, the whole discussion seems to me to still further emphasize the danger there would be in reposing the whole safety of the Panama Canal on a plain earth dam at such a site and under such conditions as exist at Bohio on the Panama route. Such a dam would have to retain a lake with a surface area of some 40 square miles of unexamined and practically unexaminable material, which would require years of minute and laborious borings over every part of it to determine the non-existence of fissures and porous seams which might endanger the structure, to say nothing of the further danger from burrowing animals of various kinds that abound in those regions.

It is undeniable, therefore, that the dam when built should have a concrete core wall down to the bed rock at any cost, and so the commission very properly decided; but to get there with the caissons, 128 ft. below water, they proposed to pump down the head of water in the cofferdams by main force, reducing it, say, 40 ft., but still leaving it necessary to work in the caissons under a pressure of about three atmospheres. Mr. Morison, in discussion, seems to doubt the feasibility of this plan; which, if even admitted, still leaves very deep, costly and slow caisson work to be done; and produces at last an unsealable, unsatisfactory, columnar wall as a core for the great dam, with the enormous pressure behind it, due to a total head of over 200 ft.

My plan is as follows: A good working shaft is sunk, at A, Fig. 2 (two or more may be sunk if convenient for more rapid work), at any desirable distance up the bank, and away from the edge of the water at normal river level. This shaft should go right down to bed rock, and its upper end above ground be suitably protected if necessary from extraordinary flood levels. The sinking of this shaft would be inexpensive in any case, and furnish the most reliable data as to seepage and pumping capacity necessary for the further operations herein described, and thus at a minimum of cost decide the seepage question of the various strata with precision, for the adoption of any other form of dam, if for other reasons the proposed form should prove unsuitable. A tunnel (No. 1) is then started in one or both directions at the bottom of the shaft in the alinement of the proposed dam, of suitable dimensions and timbered in the ordinary way, the bed rock being followed, cleansed and effectively sealed and leveled with concrete as the basis for the first tunnel floor. If the seepage is found to be great, the excavation can be lined as soon as timbered in comparatively short sections; it is possible to use the freezing process for driving the tunnel; or, at certain spots perhaps, *when* and *where* necessary, *only*, an air lock carried at the end of the tunnel would still give advantages over the other pneumatic methods hitherto proposed, for cheap and quick handling of material to be removed; and most important of all, for an absolute sealing of the bed-rock section from side to side of the valley. The gallery along the center of the tunnel would be left with such minimum dimensions as would permit of the effective handling of material in and out to the shafts, pipes for pumping and ventilation, etc. When completed these galleries could, if desired, be filled with solid concrete; but it would seem to the writer a very great advantage indeed to leave the galleries open for permanent inspection of the work at all times. The jointings of the successive sections of such a tunnel would not be either smooth or perpendicular, but preferably be left with their natural slopes at the ends—after complete ramming, to receive the filling for the next section. This would thus give a continuous and perfectly satisfactory line of hollow wall perfectly tight both in its bed joints and section joints; and it would also be desirable, instead of packing the lining close to the roof timbering, as is done in ordinary tunnels, to leave sufficient space below the roof timbering of the tunnel above the concrete for the proper ramming and depositing of the material, thus leaving a flat surface on top which would serve as the floor for tunnel No. 2. The second tunnel would then be started from the same shaft, A; the roof timbering of No. 1 being removed and the top of No. 1 tunnel practically replacing the bed rock at an elevation, say, 20 ft. higher than before; and so on in succession, tunnel would be built on tunnel, from side to side of the valley, until such height is reached or such conditions met as to



Spans, in feet	Classes C, D & E single track. Min. diam. Top d	Bot. D	No. of piles.	Classes E double track. Min. diam. Top d	Bot. D	No. of piles.
50	2'-10"	3'-4"	4	3'-4"	4'-4"	8
75	3'-4"	3'-9"	5	3'-10"	5'-6"	10
100	3'-8"	4'-2"	6	4'-6"	6'-0"	10
125	4'-0"	4'-7"	8	4'-10"	6'-4"	12
150	4'-4"	5'-0"	9	5'-2"	7'-0"	12
175	4'-8"	5'-6"	10	5'-6"	7'-6"	15
200	5'-0"	5'-10"	11	5'-10"	8'-0"	15
250	5'-6"	6'-4"	12	6'-4"	9'-0"	19

FIG. 1. TWO FORMS OF STEEL SHELL CYLINDER PIERS.

As to the advantages of the proposed method, and the advantage of such a perfect honeycomb wall, or curtain, as an additional feature to any of the forms of earth dams that have been proposed at Bohio, we thus build the most expensive and difficult parts of our core wall under water without disturbing the overlying strata; or breaking ground to let in any water from the top; or without assuming any of the risks of flood or other damage during the protracted periods of early construction. We seal the valley with a perfect and continuous wall, instead of a series of semi-detached masonry columns; or to express it in other words, we build a wall with the well-known horizontal bed joints instead of the so far unprecedented vertical bed joints proposed in the commission's plan; and last but not least, we have a wall capable of inspection at any and all times during and after construction. The first or lowest tunnel constructed would become the sump for drainage from the upper ones and so facilitate the work as it progressed by properly draining the upper strata.

As to the cost of such a plan. The problem at Bohio is simply the construction of 1,600 lin. ft. of tunnel, only differing from any ordinary railway tunnel in that the hole through the middle is smaller, and that successive sections of the tunnel are placed on top of each other instead of being continuous from the end. What will 1,600 ft. of such a tunnel, under the conditions described at Bohio, cost? Perhaps other and abler engineers will estimate more than I do. But the writer ventures to assert that he would make money

on the contract at an average cost of $250 per lineal foot for a 20-ft. tunnel outside dimensions. The 1,600 ft. would thus cost $400,000. Assuming that we double that amount to $500 per ft., which is about as much as the most costly steel-cased subaqueous tunnels have ever cost in any part of the world, we arrive at $800,000 as the cost of the seepage apron proposed by me for the Bohio dam. The question is simply this: Is it worth the sum of $800,000, in addition to the $2,430,810 total calculated for Mr. Morison's excellent earth dam, to place the Panama Canal beyond reasonable risk of any kind, and still keep the total cost of the great dam at a figure but little more than one-third the total cost of the less desirable type of structure proposed by the commission?

At any rate, it is obvious that if the commission's plan of pumping down the head of water in the cofferdams is feasible at all at Bohio, it is much more feasible to pump out the seepage from my tunnels, especially when no hole at the top has been made for letting the water in from the river. I would work without compressed air at all, and be safe from flood damage during the whole period of the really difficult and dangerous stages of the work, and possibly without any auxiliary dams at all.

THE DESIGN OF CONCRETE PIERS WITH METAL SHELLS.*

By Theodore Cooper, M. Am. Soc. C. E.

For such piers either one oblong shell or two cylindrical shells braced together can be used.

For soft bottom or where piles can readily be driven into the material of the bottom, the shells should be sunk into the ground well below any possible scour, by weighting the shells and excavating the material from the inside. The inclosed space should then be filled with piles of such lengths as will permit driving to a "good refusal," with their tops at low-water level. The piles should be kept free from the metal shell 4 to 6 ins., and the spaces between the piles must be less than the size of the smallest pile used. For the oblong shells this close spacing need only apply to the end portions, symmetrical with the center of the bearings of the trusses. The spaces between and about the piles must then be well filled and rammed with Portland cement concrete. The shells above low water shall then be pumped dry and filled with Portland cement concrete in well-rammed layers to the top, where it must be finished off in proper shape for the bridge seats and drainage.

For material which can be excavated from the inside of shells to a sufficient depth below possible scour, but which does not need piling, the shells should be sunk to the proper depth, the bottom sealed against the admission of water by depositing concrete through pipes or in bags, then pumped dry and the interior properly filled with Portland cement concrete. Or the bottom may be dredged beforehand to a proper level and the shells bolted rigidly to a timber platform or grillage and then sunk as an open caisson.

For rock bottom, where it is possible to fit the platform to the rock surface, this form may be used, but where the weight of the piers is not sufficient to give abundant security against the shoving action of floods, ice or floating material, the platform should be anchored securely to the rock by anchor bolts.

For rock or hard bottom, cylinder piers may be steadied and also protected from scour by a surrounding crib, as shown on Fig. 2. After the crib is placed and sunk by filling the floored pockets with broken stone or concrete, the cylinders should be lowered into place through the open pocket provided for them; then the open spaces outside of the cylinders should be well filled and rammed with Portland cement concrete to the full depth of the crib. Then the interior of the cylinders should be pumped dry and filled in the usual way with concrete. Where the crib cannot be sunk to the rock, owing to the overlying mud, sheet piles or sheeting can be driven around the periphery of the open pockets to the rock and the mud removed, before placing the cylinders or depositing the concrete.

The permanency of the wooden crib in fresh water and the protection of the metal shell on both outside and in by cement concrete give this style a superiority over those where the outside of the shell is in direct contact with the water, and hence subject to continuous oxidation.

Little or no faith should be put in the claim that when the metal shells do finally rust away, the concrete core will be able to serve the full purpose of a pier, even for the best concrete work, and when the concrete is deposited through the water as has been the usual custom heretofore it will probably be found to be no better than loose stone.

*Extracted, by permission of the author, from his forthcoming "General Specifications for Foundations and Substructures of Highway and Electric Railway Bridges." Copyright, 1902, by Theodore Cooper.

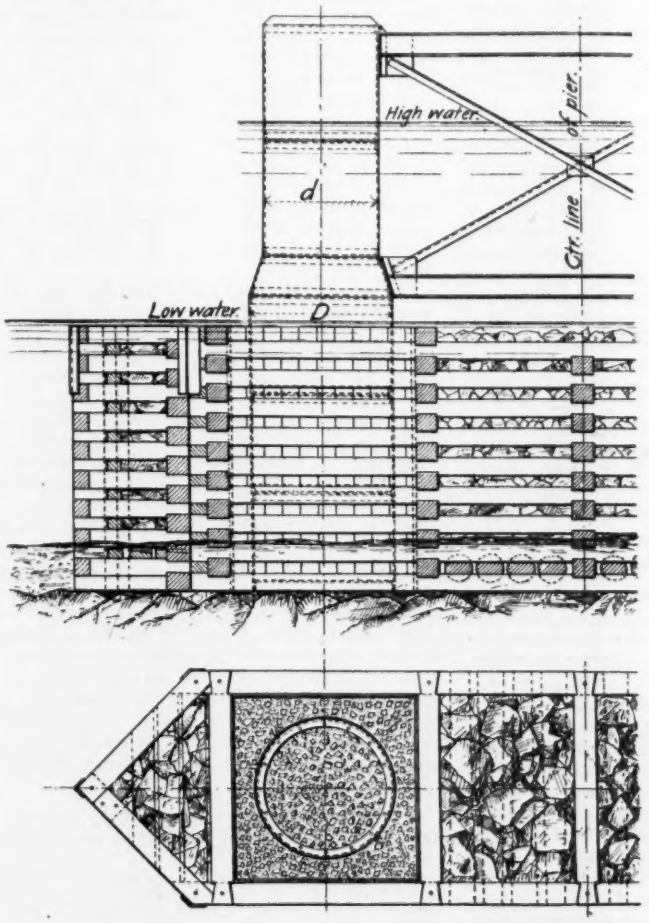


FIG. 2. CYLINDER PIER ON ROCK WITH CRIB PROTECTION.
(Dimensions as in Fig. 1.)

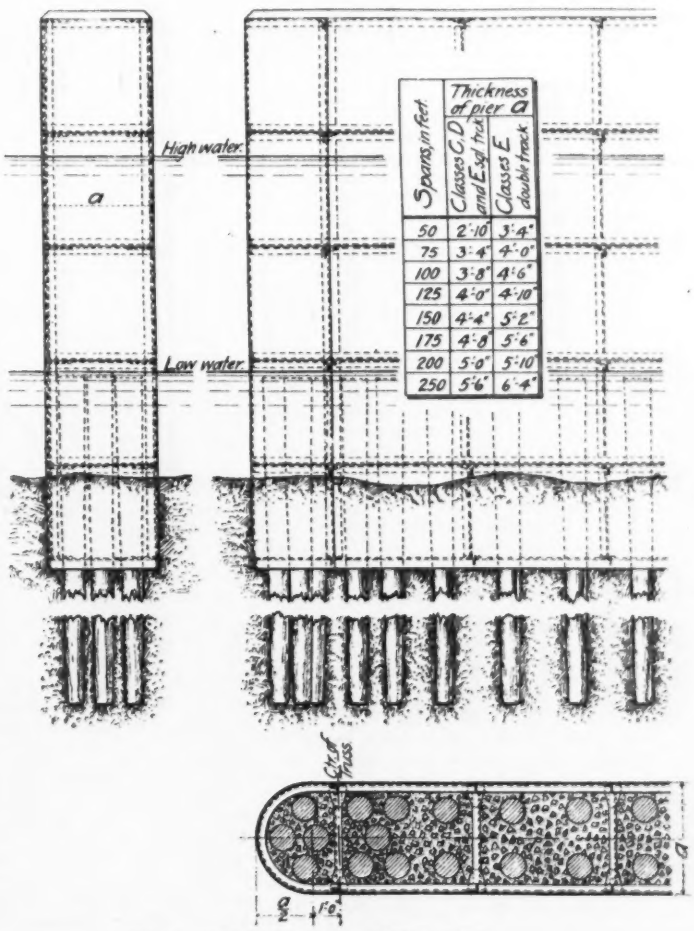


FIG. 3. OBLONG STEEL SHELL PIER.

A NEW METHOD OF COOLING TUYERES.

A novel system of tuyere cooling in blast furnaces is described by Horace Allen in the "Journal of the Steel and Iron Institute." It might well be called the method of aspiration for causing the water to circulate in the tuyeres; for while at present water is forced through the tuyeres, the new method sucks it through. Unimportant as this difference may seem at first sight, in practice it has proved very valuable. Using the present method if a leak once starts it tends to increase, while the new method, by sucking slag and iron into the hole, plugs it up. Furthermore, in case of a bad break in the tuyere, the furnace cannot be flooded with water where the aspiration method is in use. The new system is readily applied to existing furnaces and tuyeres, a reliable pump of size sufficient to permit a low piston speed of about 100 ft. per minute being the only requisite. Where a sufficient fall (20 to 25 ft.) is available the addition of a syphon pipe will greatly assist the pump and insure a steady aspiration. Owing to freedom from slag accumulations where aspiration is used a tuyere can be changed in five minutes, which is quite an item. By means of an automatic mercury gage fitted with an electric alarm, even a small leak in the tuyere is instantly detected, with the result that the tuyere is repaired before it would otherwise cause the quality of the pig iron to fall to "Forge."

This system of cooling by aspiration of the water was invented by Mr. W. J. Foster; and in the discussion following its description all were unanimous in commending it.

One surprising fact was brought out in the discussion. It is that cast-copper tuyeres used in England are all purchased in the United States.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
} ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE., 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.00 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current Volume, 15 cents.

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year: for instance, the number 323 means that subscription is paid to the 32d week (that is the issue of Aug. 6) of the year 1903; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

The recent closing down of several large Montana copper mines pending legal decisions as to ownership brings up anew the weakness of existing mining laws in the United States.

The main causes of the vast amount of litigation in Western mining districts are three in number: (1) The fact that the side boundaries of a mining claim in no wise limit the underground operations; (2) The loose system of recording claims, often on improvised books in the hands of irresponsible men; (3) The making of district laws by the miners themselves, which have all the force of any law provided they do not conflict with Federal acts.

There is probably not a mining engineer who would defend any of these three conditions, except the first, and even that would probably meet with condemnation if put to vote. In theory the law which permits a miner to follow a vein to the center of the earth if he can do so, regardless of the fact that in so doing he may be taking ore from beneath the land surface owned by others, is perhaps a good theory where there is but one clearly defined outcropping in any given section. When, however, there are numerous veins, and spurs, many of which are by no means clearly defined, as so often happens, we have a condition and not a theory confronting us. The disastrous intimidations of capital and the locking out of thousands of miners call loudly for a decided reform in Congressional legislation governing mine location.

In the Johannesburg district of South Africa, over a tract 2 to 3 miles wide and 40 miles long, there is not a square foot of land not covered by mining claims; yet, according to Mr. John Hays Hammond, litigation is practically unknown. The reason is clear, for the claims (each 150 × 400 Cape ft.*) entitle the owner to go as deep as he may within his 1.47 acres, but not an inch beyond the vertical planes passing through the claim boundaries. The law in the United States regarding other than precious minerals, is essentially the same as the South African law. We fail, in view of these facts, to see any good reason why precious mineral veins in the United States should be treated differently from any other mineral deposits in this country, or from precious mineral deposits in other countries where claim locations are based upon the old Spanish mining law.

The present law is based upon the old theory that precious mineral deposits always exist in dikes or impregnated fissure deposits between clearly defined walls of country rock. But as the theory is not universally in accord with actual conditions, the law based upon it has led to the enrichment of lawyers and "legal mining experts" at the expense of the miners. Where theories are incomplete or vague, controversies will arise beyond number, and where laws are based upon incorrect theories, such controversies will be carried to the courts.

The great dam across the Chagres River at Bohio will be doubtless the most important engineering work in connection with the Panama Canal. The methods to be adopted for its construction constitute one of the most interesting engineering problems now before the profession. Briefly stated, the conditions are: A depth to rock greater than that at which the pneumatic process has ever been used, and a river subject to sudden and enormous floods. The Isthmian Canal Commission proposed to make a water-tight curtain wall through the lower part of the earth strata by sinking a succession of shafts side by side to bed rock and filling them with concrete. Mr. Geo. S. Morison, in a paper before the American Society of Civil Engineers (Eng. News, March 13, 1902), proposed to dispense with this curtain wall, and presented data to show that the seepage through the underlying porous strata would be too small in amount to endanger the safety of the structure or to notably affect the volume of storage.

In a paper in this issue of Engineering News Mr. J. P. Ford proposes a novel plan of making the curtain wall through the lower permeable strata. He would drive a succession of tunnels, one over the other, and fill them with concrete.

Comparing his plan with that of the Canal Commission's it will be conceded at once that the joints between successive filled tunnels would be easier rendered water-tight than between successive shafts. Whether the tunnel work could be as well carried out to secure effective filling down to the surface of the bed rock would seem a matter for consideration. It would be necessary in all probability to use the shield system of tunneling and the troubles with that system in passing from earth to rock are pretty well known. The question may be asked, what measures could be taken if the ground proved to be heavily water-bearing, and if the inflow proved too great for the pumps to handle, even when compressed air was used at pressures as high as climatic conditions would permit? The Commission proposed to sink its shafts inside a great coffer-dam, in which the water level would be lowered 40 ft. or so below the river level, and in that way make it possible to carry sufficient air pressure to keep back the inflowing water. Perhaps a similar plan might be feasible with Mr. Ford's tunnelling scheme.

In the article on "Columns for Buildings," by Capt. J. S. Sewell, in our issue of Oct. 23, there is a statement which suggests one or two questions which seem worth some discussion. We quote as follows:

> Among the works executed by one of the companies now engaged in exploiting reinforced concrete are many cases of concrete (columns.—Ed.) reinforced against compression by bars of moderate size imbedded in the mass. In some cases these bars are so close together that they almost touch throughout the entire section of the composite member. They are figured in simple compression at about 16,000 lbs. per sq. in., and have nothing but the concrete to prevent them from buckling. They stand under strains that the bundle of bars alone could stand for a moment without buckling, and yet the concrete around them seems absurdly small in amount.

*1 Cape foot = 1.033 ft.

The last sentence above quoted at once suggests that in order to form a substantial column of this class the concrete must be of good quality. It is worth while considering whether with ordinary workmanship it would be practicable to obtain the requisite quality in this concrete. If the reinforcing bars "are so close together that they almost touch throughout the entire section," how is the concrete to be placed between them and properly compacted to produce a solid, strong, monolithic mass?

Suppose it is desired to build a concrete-steel column, reinforced with bars, as described, say at least 12 to 15 ft. long, and carrying floor beams which may be of similar concrete-steel construction. It is necessary first to place the bars, and to connect them where necessary with the reinforcing bars of the floor beams at their upper end. A form is then built around the bars to serve as a mold for the concrete, and the latter is then placed around and between the reinforcing bars. It is dropped between the bars from the top of the column, or it is worked in between them from the side. In either case it would seem that ramming of the concrete is practically out of the question, and if there be any large fragments of gravel or stone in the concrete, it would be difficult to prevent them from wedging in such a way as to produce hollows or weak spots in the concrete.

We emphasize this rather obvious matter of proper "placing" of the concrete because it enters as an important consideration in any decision as to the applicability and value of concrete-steel in work of the class considered. In the article of Capt. Sewell, quoted above, the final paragraph expresses the author's belief in a future wide use of concrete-steel construction in building work, including columns, beams, floors and all. And again, in our editorial in the same issue, we restated the same idea. We think it well, however, to caution the engineer that when the concrete and not the steel becomes the chief factor in the strength of the structure, the quality of the concrete becomes all-important. Precautions must be taken to secure actual monolithic construction. Further than this, in examining the numerous new types of concrete-steel combinations which are brought forward nowadays, it is important to consider not only how the combination will work when completed according to theory, but how, as a practical matter, the concrete can be effectively and economically placed.

One of our contemporaries devoted to mining interests prints the following among its answers to correspondents:

> Q. In your issue of June 14, you state that there are about 2,000 different minerals, but only 40 of any importance to the miner. I would be pleased to learn the names of the 40.

The editor's answer is a curious catalogue, including among others the following "minerals of importance to the miner:" Iridium, palladium, rhodium, osmium, potassium, sodium, diamond, granite, feldspar and water.

We had heretofore labored under the impression that rhodium was not commonly handled by miners, that sodium was an element and not a mineral, and that granite was a rock composed of three minerals. Since the editor included so many "important" things not minerals, we are surprised that he omitted alcohol and hardtack.

THE RENAISSANCE OF THE SAILING VESSEL

It is seldom that we have the pleasure of presenting to our readers matter of greater popular interest than that which we give this week relating to the new seven-masted schooner, built this season at the Fore River Ship Yards at Quincy, Mass.

More or less information of a popular nature has appeared in print concerning this vessel, and some of our readers who are members of the American Society of Mechanical Engineers or the American Foundrymen's Association had an opportunity of examining the vessel while she was on the stocks, during excursions of the above-named

societies to Fore River in connection with their annual conventions. The illustrations and description in this issue of Engineering News, however, are the first complete presentation of the vessel to be published.

We believe this vessel and the possibilities which she makes evident are worthy of the most careful attention from engineers and from all who are in any way interested in the large problem of cheap ocean transportation.

It has for years been assumed as a matter of course that the sailing vessel was doomed to disappear as a freight carrier from the high seas. This conclusion has been reached chiefly by a study of statistics, which have showed from year to year for a half-century a progressive diminution in the sailing tonnage and a steady increase in the steam tonnage of the world. Judging the future by the past, it is easy to foretell the final complete victory of the steamship and the end of the use of wind power for navigation.

But such a forecast of the future leaves out of account the entry of new elements into the problem; and such new elements often change the whole aspect of a problem of engineering or economics.

As an illustration of this: Any one in the early '80's, judging the future by the past, might have prophesied that the use of water power for any large industrial operations had reached its maximum, and that steam power would replace it in a large proportion of the existing plants. But the application of the electric current for lighting and power purposes, and particularly for the manufacture of chemical products has changed the entire situation and has set thousands of water wheels doing work which was hardly dreamed of twenty-five years ago.

Who can say that a like renaissance may not await the use of wind power for ocean navigation? We are aware that it is customary to regard wind power as of trifling importance—as something which the present age of steam and steel has outgrown. But the oft-defined task of the engineer is to harness the great powers of nature for the use and convenience of man. Of all these powers at man's service, none is so widely distributed, and none can compare in magnitude with the wind. At a recent convention of U. S. Weather Bureau officials, one of the speakers said:

> I doubt if the fact is fully realized that there is sufficient power which can be had for the taking, within 100 ft. of the ground in a space 5 yds. in diameter, to do all the work to be done on a 40-acre farm, from the sowing, cultivating, harvesting, thrashing, and marketing of the crops, to the rocking of the babies and the doing of all kinds of housework, and to furnish light, heat, and ice for the house, and electric light for the chickens to sleep by.
>
> The energy utilized at Niagara Falls is not more sure in its annual quantity than the energy which wastes itself over a Dakota farm. The Niagara energy, however, exerts itself in one direction the year through, is very much condensed, and stable in quality and quantity from day to day. On the other hand, the energy to be derived from the winds at a given velocity varies with the pressure, the temperature, and other conditions of air, and varies in intensity from nothing to 100 miles an hour in succeeding minutes. But when the coal fields are gone, and the forests are burned up, and the oil fields are pumped out, there will always remain this universal force distributed almost everywhere on the face of the earth, which can be utilized for almost every known human need which physical energy can supply. Either storage of compressed air, or the production of liquefied air, or the storage of electricity will probably, in the near future, be largely employed to utilize wind power for many human needs, in addition to the countless uses already being made of these energies.

But of all the applications of wind power that man has ever made, none has had so wide a success or such commercial importance as the propulsion of ships at sea. In fact, except for the use of human muscle, and except for the use of steam during a period extending back no farther than the memory of men now living, wind power alone has done the entire work of vessel propulsion for mankind from a time earlier than the dawn of history.

Why, then, has wind power so largely been displaced by steam on the high seas? The answer is, because steam has been found to be superior for promptness, reliability, safety and in most lines of trade, for economy. It is of interest to note, however, that economy as a governing factor in ocean transportation is really a thing of very recent times. We need go back less than a century, to the days when the old wooden merchantmen from Boston and Salem sailed every sea, to reach a time when the element of risk and chance was so great in the shipping trade that the element of economical carriage was of small consequence. Shipping in those days was correctly described as a "venture;" or to state it more correctly, all overseas commerce was a venture. The merchant engaged in the India trade or the China trade, or even the trade with Europe, had to make great profits to compensate for the risks he ran.

All this, however, belongs to a past age. Ocean transportation has become like everything else a specialized industry, and one in which free international competition makes the margin of profit a narrow one. At the present day the tramp steamer and the huge freight carrier of the regular steamship lines, are competing for the business of freight transportation at sea. The old-time square-rigged sailing vessel can still compete with these only on the very long voyages, where the coal which the steamer requires and the weight of cargo which it displaces, handicaps the steamer in the competition. The question is, now, whether the new large-schooner type of vessel, such as that illustrated on our inset sheet, can prove a better competitor, and if so, in what respect.

The most striking difference, of course, between the new schooner and the old-time square-rigged vessel is in the crew carried. It is the size of her necessary crew that kills the old-fashioned square-rigged vessel as a cheap freight carrier. The duration of the voyages of a sailing vessel is of course much longer on the average than that of her steam-propelled competitor, and the wages and board of the crew for the additional time go far to offset the fuel bills of the steamer. The square-rigged vessel has to carry a large crew because all her sails are worked by hand power. Owners of square-rigged sailing vessels have cut down their crews to and even beyond the line of safety, and the complement of men now carried is often not half the number that were carried before the days of steam, when quick voyages for the carriage of passengers and high-class freight were of great importance. Beyond this the square-rigged vessel cannot go, and as stated in the paper by Mr. Jones in this issue, while the seven-masted schooner is worked by a crew of 16 men, a square-rigged vessel of the same size carries 40.

If we bring the tramp steamer into the comparison, we find that while the square-rigged vessel requires a larger crew than a freight steamer of the same size, the schooner requires a much smaller crew than the steamer. As a rough estimate, we should judge that on an average voyage the smaller crew, and the fact that no skilled engine-room force is required on the schooner, would about offset the longer time required for the voyage, and would make the running expenses of the steamer and the schooner for wages and board about equal. Thus, the schooner has left as a net advantage over the steamer the cost of the coal and other supplies and the maintenance of the steamer's propelling machinery.

It will very likely have been perceived by the reader that the new schooner depends for its successful operation on the fact that its sails are handled by steam power. Were human muscle relied on to handle the enormous sheets which this vessel carries, the vessel would require a crew as large probably as the square-rigged vessel. So long as sails are worked by hand the square rig is probably as good as the schooner rig, and even better on vessels of large size. With sails of a size suitable to be worked by hand, enough canvas cannot be spread with a schooner rig to give a vessel satisfactory speed. It is the adoption of a rig that permits the use of steam instead of human muscle to spread the sails that really gives the new type of vessel its great advantage.

And now let us turn to some other contrasts which the new vessel presents over the old square-rigged vessel. One of the most striking is in the conditions of work and the comfort of the crew. It is a familiar saying that a sailor's life is a dog's life. It is heartbreaking work to handle the heavy gear of an old-time sailing vessel, and this with the risk attending work overhead in all weathers and the evil conditions of the crowded forecastle tend to make the sailor's life shunned by all save the reckless.

But on such a vessel as the "Lawson" the conditions of the sailor's occupation are vastly different. The hauling away on heavy ropes and the hoisting of the anchor is done by arms of untiring steel. The overhead work is almost wholly done away with. The small size of the crew makes it no longer necessary to crowd the forecastle, and makes it possible to give the crew decent fare. Steam heat in the living room spaces gives comfort to men coming off watch after work in a winter storm. We may even point out, though it is a minor matter, that the steady motion of the sailing vessel compared with the constant rolling of a steamer in a seaway might do much to redeem the sailor's life from the evil name it now bears.

Excellent testimony to the conditions of life on board the "Lawson" is furnished by a series of photographs before us, some of which are reproduced elsewhere in this issue. The galley looks as if it were copied from the kitchen of an up-to-date hotel. The captain's cabin is as well furnished and more spacious than the highest-priced "apartments de luxe" on a modern Atlantic greyhound. So in every respect the living conditions on this new sailing vessel are in vivid contrast to those on board the typical sailing vessel or tramp steamer.

There is one feature of the "Lawson," however, which we feel bound to criticise, and which we believe will be altered in the construction of later vessels of this type. We refer to the absence of auxiliary steam propulsion.

We have before expressed the opinion in these columns that the most economical type of freight carrier for ocean transportation would yet prove to be the sailing vessel with auxiliary steam propulsion, sufficient, say, to give the vessel a speed of 3 to 4 knots in a calm. Already hundreds of sailing vessels of moderate size are in service equipped with auxiliary power, and we must confess our surprise that it was not provided for on the "Lawson." The vessel is already equipped with boilers capable of developing about 80 HP., and a rough calculation shows that a boiler and engine capacity of only about 200 HP. would be sufficient to move her at a speed of some four knots through smooth water, or at nearly as good a speed as the average rate attained by sailing vessels on long voyages, taking delays of calms and contrary winds into consideration.

The value of such auxiliary power for making better speed on a voyage is perhaps its least important function. It adds greatly to the safety of the vessel. The greatest danger that besets a sailing ship, probably, is being cast on a lee shore. In a calm, a vessel propelled by sails alone is at the mercy of tides and currents. In a storm, too, a heavy laden vessel is often unable to make headway against the wind and she drifts ashore in spite of all the efforts of her crew. Auxiliary power in almost every case would save the day and enable the vessel to beat off from a dangerous coast.

Again, in the navigation of channels in bays or sounds and in entrances to ports and in harbors auxiliary power would be of the greatest service. Indeed, if we are rightly informed, the "Lawson" has already been aground in Delaware Bay—a good illustration of the difficulty in navigating in contracted waters with sails alone. The saving in tug charges alone on a vessel entering New York or Boston harbors would go far, we judge, to pay the entire cost of running auxiliary power in such a vessel.

Of course we are aware that there are some engineering problems which need study in the application of auxiliary power to large sailing vessels in order to secure the best results. It is difficult, for example, to provide a screw propeller that shall be efficient at low speeds and yet no drag on the vessel when running under sails alone. But these and similar problems are by no means insuperable, and it seems quite possible by the use of screws of adjustable pitch in connection with engines and boilers capable of heavy forcing to provide a sailing vessel with a very respectable power for her salvation in an emergency, without

transgressing moderate limits of cost, weight or space occupied.

We might proceed in such greater detail to discuss the economic possibilities of the large size sailing vessel using steam for handling sails and as an auxiliary reserve power for propulsion, but we have already reached the limit of our space.

What we have said, we are sure, will lead engineers to give careful heed to this subject. Such engineering problems as the construction of ship canals, of port entrances, of harbors and docks are closely connected with the future type of freight vessel.

We have spoken above of the entrance of new elements into engineering problems and the changes which are thereby brought about. Any forecast of the future must take account of the fact that the cost of coal, and of all fuels which can avail as partial substitutes, is bound to increase, not as a temporary matter, but permanently. Every such increase betters the chance of the sailing vessel in the competition and handicaps the steamer. We need only assume a large enough increase in the cost of coal to see the tramp steamer disappear and the picturesque sailing vessel restored to its old place as a carrier of international commerce.

LETTERS TO THE EDITOR.

Some Reasons Why Piles Are Ruined In Driving.

Sir: I have read with a great deal of pleasure the discussions on pile driving that have appeared in your columns lately. I fully agree with those engineers who say piles should be driven with a steam hammer, or by striking quick, short blows with a drop hammer. I know that more piles are ruined by the old grandfather specification, "Piles shall be driven until they show a resistance of not more than 1 in. to the blow of a 2,000-lb. hammer falling 30 ft.," than by any other cause.

There is another reason, however, why piles are often ruined. A great many times the engineer in charge of construction has young men sent to him, who are either relatives of some of the railroad officials, or sons of influential citizens, with instructions to give these young men some good job that will not be too hard on them at first, and as the "pile recorder's" job is about the only easy one an engineer has at his disposal, he sets these inexperienced men to this work. This works a hardship on the contractor doing the work, and is detrimental to the railroad and at the same time is an injustice to the young men placed in these positions.

It is my opinion that engineers in charge of pile driving should be men of education and experience, being competent to tell what kind of timber is suited for the different kinds of material that have to be driven through, also to know how much drop the hammer being used should have to obtain the best results under the various physical conditions that present themselves, and last to know when to stop driving the pile.

Very truly yours, Woolsey Finnell.

Tuscaloosa, Ala., Oct. 25, 1902.

More About Scow Measurement.

Sir: For the information of your correspondent, who wishes to know of a method of determining the load on a scow or barge by displacement, I submit the following which has been in use by the United States Engineers on Mississippi River improvement for some years.

The water line is first taken of the barge when light; that is unloaded. This water line is measured on each side, and the average of the two sides is called the light water line. Five gagings are taken on each side, making a total of ten. On each side one is taken at each end, one in the middle, and two intermediate between the center and each end. All of these gagings, except the four end ones, are multiplied by two, and the total then obtained by adding the sum of the end readings and the readings which have been doubled is divided by 16, to obtain the average gaging, which is the average depth of immersion of the vessel.

The same operations are gone through with the load on the barge or scow. That is, the average *load* water line is found by taking the length of the water line on each side of the vessel, and the average of the two determined. Ten-gage readings are taken of the loaded barge, five on each side, and treated as above. The data obtained is applied as follows, which will give the weight in tons. The measurements should be taken in feet as the weight of water is taken as 62.5 lbs. per cu. ft.

$$\left(\frac{\text{Average water line, light} + \text{average water line, loaded}}{2}\right)$$

× width of barge × (average loaded gage — average light gage) × 62.5 ÷ 2000.

This method is for a rectangular cross-section. Where the scow or barge has a "rake," the end gagings must be taken at the intersection of the rake with the horizontal bottom. Respectfully,

L. E. Lion, Assoc. Mem. Am. Soc. C. E.

Natchez, Miss., Oct. 28, 1902.

The Value and Significance of Certain Cement Tests.

Sir: In Engineering News of Oct. 16 Mr. H. A. Young refers to the article on cement tests in the issue of Sept. 25 and raises some questions relative to the boiling test, particularly regarding the cement adhering to the glass. I am thoroughly convinced that little information regarding the character of a cement can be obtained from the mere fact that the pats do or do not adhere to the glass during boiling. It is true that any cement which cracks badly or disintegrates will leave the glass and it is also true that first-class cements which will stand the boiling test perfectly in other particulars will frequently be free from the glass after a few minutes boiling.

This is probably due to a sudden change of temperature or to the temperature of the glass and cement not changing exactly together, causing enough difference in expansion to overcome the slight adhesion.

The object of the boiling test, as the writer understands it, is quickly to get an indication of the condition which a cement will be in after having been set a long time. In other words, the boiling tests were designed to take the place of tests extending over extremely long periods. The most important conditions which effect the boiling test are the consistency of the cement paste, the manner of placing it on the glass, and the temperature of the water into which the pat is placed just before boiling. Cement testers lack sufficient knowledge of the conditions which effect this test and of the results obtained to make the test of the value which it should be to them. The writer would suggest that all cement inspectors, who chance to see this letter, make a series of boiling tests, the object being to ascertain all the conditions which effect this test and also to determine the age of an unboiled cement which corresponds to a given time of boiling. If this were known we would be able to predict closely the results of a six months' or year test in a few hours. If these tests were made and the results tabulated so as to occupy as little space as possible the Engineering News would probably find space to publish them.

Each tester should confine his work to one brand of cement and make the pats in the ordinary manner; that is, the consistency should be such that a ball of cement paste dropped 1 ft. will not crack. The cement paste used for pats should be rolled into a ball, placed on the glass, and flattened by drawing the trowel from the center to the sides, so as to give the pat a finished diameter of about 3½ ins. and a thickness at the center of ½-in. The briquettes used for the comparison of the boiling and age tests should be made at the same time and in the same manner. Respectfully,

Pitson J. Cleaver, Jun. Am. Soc. C. E.

189 Montague St., Brooklyn, N. Y., Oct. 28, 1902.

Temperature Stresses in Aluminum Transmission Wires.

Sir: It has been my experience that altogether too little attention is usually paid to temperature stresses when putting up the wire on transmission lines; it occurs to me that a formula which I have often found useful may prove of interest to some of your readers.

The formula is particularly useful in stringing aluminum wire of the smaller sizes. It is desirable to know what sag to give the wire, with a given span, so that a possible fall of temperature will not cause excessive stress. Carelessness in this respect has been the cause of more wires snapping in cold weather than even the collection of sleet on them, I believe.

$$f = m e (t - t_1) - \frac{8 m d^2}{3 s^2} + \frac{q s^2}{8 d}.$$

f = stress per sq. in. at center, at t_1 (minimum winter temperature);
e = coefficient of expansion;
m = modulus of elasticity per sq. in.;
d = sag in wire, when strung (at temperature t), in ins.;
s = pole spacing, ins.;
q = weight of the metal per cu. in.

Put f = 11,000, and m = 9,350,000 for aluminum.

Yours truly, R. D. Johnson.

Buffalo, N. Y., Oct. 1, 1902.

(We do not quite see how the term d is to be found from the formula given by our correspondent, since in the form shown the equation is of the third power in d. A quite simple method of allowing for temperature in fixing the deflection is given in the handbook "Wire in Electrical Construction" of the J. A. Roebling's Sons Co., of Trenton, N. J. The same method, with even simpler formulas, is given by Mr. L. Bell, in "Electric Power Transmission," pp. 471-474, thus:

The tension $T = \frac{L^2 w}{8 d}$;

where L = length of span, w = weight per [illegible] and d = deflection at center. From this the maximum allowable deflection, for the maximum tension T, is found. The length of wire corresponding to this is,

$$L_1 = L + \frac{8 d^2}{3 L}.$$

Now with any temperature rise t the increase in L_1 is $t a L_1$, where a is the expansion coefficient of the wire. The increased L_1 is used in the last formula to find the new d, or the deflection at the increased temperature, and from this the tension at time of stringing can be found.—E.)

Retarding the Setting of Cement by Continuous Mixing After Wetting.

Sir: In nearly all specifications for hand-mixed concrete work there is found a clause stipulating that the concrete shall be placed in the work before the cement has begun to set. Quite frequently, however, some circumstance will delay the placing of the concrete in the work as soon as could be desired after being mixed, and the question arises: To what extent, if any, can the concrete be kept alive and by what means?

An experiment, suggested by this question, was conducted in this city some months ago to determine the effect of continuous mixing upon the strength of mortar. Two tests were made, one with neat cement and the other with 1 part cement to 2 parts sand. The mixing was continuous and no new material was added during the test. The briquettes were allowed to set one day in air and 14 days in water. The cement used was Atlas Portland and the sand was screened bank sand, passing through a No. 20 sieve and stopping on a No. 30 sieve. The quantities used in the neat test were 304 oz. of cement, and 55 oz. of water, and in sand test 99 oz. of cement, 220 oz. of sand and 24 oz. of water.

The table gives the results of the tests and is self-explanatory. Very respectfully,

G. Y. Skeels, Assistant City Engineer.

Sioux City, Ia., Oct. 25, 1902.

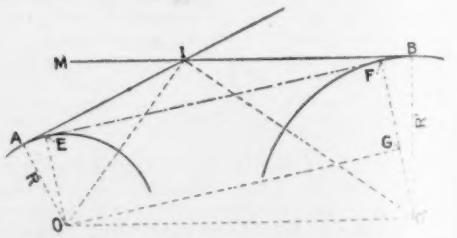
Table Showing Effect of Continuous Mixing after Wetting on Tensile Strength of 15-day Briquettes of Cement Paste and Sand Mortar.

Neat cement.				1 cement to 2 sand.			
No. of briquettes.	Continuously mixed, hrs.	mins.	Average tensile strength, lbs.	No. of briquettes.	Continuously mixed, hrs.	mins.	Average tensile strength, lbs.
2	0	20	816	4	0	15	294
2	0	40	862	2	0	30	278
2	0	55	677	2	0	45	282
2	1	10	636	2	1	00	243*
2	1	40	865	2	1	25	275
2	2	10	683	2	1	55	283
2	2	40	806	2	2	25	287*
2	3	10	760	2	2	55	314
2	3	40	790	2	3	25	326*
2	4	10	470†	2	3	55	372
2	4	40	675	2	4	25	334‡
2	5	10	564	2	4	55	384
2	5	40	746	2	5	25	264
2	5	40	656‡	2	5	55	249
2	6	10	697	2	6	25	308*
2	6	40	634	2	6	55	290*
4	7	10	678	2	7	25	217
2	7	10	752*	2	7	55	327
2	7	40	696	2	8	25	255
2	8	10	636*	4	8	55	236
2	8	40	586	4	8	55	220*
2	9	10	767	2	8	55	215*
2	9	40	695				
4	9	40	636*				

*Two oz. of water added; †6 oz. water added; ‡3 oz. water added.

A Novel Method of Connecting Two Curves with a Tangent.

Sir: I submit herewith a method of finding the tangent points required to connect two curves with a common tangent, the curves being exterior to each other. The method given in "Henck's Field-Book" is an approximation only, while the method given in "Searles'" involves the finding of parallel radii—something of a problem in itself in actual field work. I have therefore worked out a method by which a common tangent may be found, reference being had to the accompanying figure, as follows:



Given two curves of known radius; assume points A and B; sought points E and F.

By inspection assume two points A and B on the curves, back of the required tangent points E and F; run tan-

gents to the curves at A and B, and find the point of intersection, I.

Measure the angle M I A with the transit, and the distances A I and B I with the chain.

A O = the radius (R) of curve A E;
B O′ = the radius (R′) of curve B F.

Join O I and O′ I.

In the triangle A O I, angle O A I = 90°, being formed by a radius and tangent.

$$\tan A I O = \cot A O I = \frac{A O}{A I}. \quad (1)$$

$$O I = \frac{A O}{\text{sine } A I O}. \quad (2)$$

In the triangle B O′ I, angle I B O′ = 90°, being formed by a radius and tangent.

$$\tan B I O' = \cot B O' I = \frac{B O'}{B I}. \quad (3)$$

$$O' I = \frac{B O'}{\sin B I O'}. \quad (4)$$

Join O and O′, then in the triangle I O O′, angle

$$O I O' = 180° - (M I A + A I O + B I O'). \quad (5)$$

In (5), according to hypothesis, M I A has been measured with a transit, while A I O and B I O′ are found from (1) and (3).

$$O O' = (I O' + I O) \frac{\cos \tfrac{1}{2} (I O O' + I O' O)}{\cos \tfrac{1}{2} (I O O' - I O' O)}. \quad (6)$$

but

$$I O O' + I O' O = 180° - O I O'. \quad (7)$$

wherein O I O′ is ascertained by (5) and the value inserted in the numerator of (6), while the value of I O O′ − I O′ O in the denominator may be ascertained by using

$$\tan \tfrac{1}{2} (I O O' - I O' O) = \frac{I O' - I O}{I O' + I O} \tan \tfrac{1}{2} (I O O' + I O' O). \quad (8)$$

Then, by substitution in (6) the value of O O′ is ascertained.

Draw O G parallel to the required tangent E F; then O G O′ = 90°.

$$O' G = R' - R. \quad (9)$$

$$\sin G O O' = \frac{G O'}{O O'}. \quad (10)$$

$$\text{Angle } A O O' = A O I + I O O'. \quad (11)$$

$$\text{Angle } A O E = A O O' - (G O O' + E O G). \quad (12)$$

In (12) the value of G O O′ is found by (10), and E O G = 90°.

$$A E = L = 100 \frac{\sqrt{\Delta}}{D} = 100 \frac{A O E}{\text{Degree curve}}. \quad (13)$$

Knowing the value of A O E, calculate by (13) the distance A E which it is necessary to move up along the curve from the assumed point A to the required point E at which point the tangent is common to both curves.

To find the length of the common tangent, calculate the side O G in the triangle O G O′.

When the curves are reverse to each other, assume points A and B, one forward of, the other back of, the required tangent points, and proceed as before. The line through O parallel to the required tangent will intersect O′ F produced in point G, so that O′ G = (R′ + R), otherwise the solution does not materially differ from that for curves exterior to each other.

Yours truly, C. W. Baldridge.

Engineer's Office, Chicago & Northwestern R. R.,
Winona, Minn., Oct. 5, 1902.

The Electric Smelting of Iron Ore.

Sir: The short item in regard to the electric smelting of iron ore in Sweden, printed in your issue of Oct. 2, gives very valuable and apparently authentic figures for the power required per ton of production and it is, to my knowledge, the first time that results of electric smelting of iron ore on a large scale have been made public.

It may therefore be interesting to compare these results with the figures given in the prospectus of the Massena Electric Steel Co., 52 William St., New York. Here are a few quotations from the prospectus:

Steel is king. . . . It is apparent that one who can materially lessen the cost of steel has by that act made a fortune. By reading on, it will be seen that the process which is carried out by the Massena Electric Steel Co. not only lessens the cost of steel, but makes such cost less than the present cost of pig iron. . . . It is the latest development of electricity which has practically cut in half the present cost of steel. . . . It remained for Mr. Michael R. Conley, of New York city, to discover that, by the use of a strong electric current, he could generate greater heat than by any ordinary means of combustion. . . . It is proposed to begin business with a plant capable of producing 100 tons of steel per day, and this output will be rapidly increased. It will surprise iron and steel men to know that the cost of the necessary furnaces and equipments is only about $25,000, and $25,000 or $30,000 more will run the business, but it is proposed to raise $100,000, so that the business can be done to the best advantage.

It will be information to the readers of Engineering News that Mr. Conley is the discoverer of the fact that the electric current produces a greater heat than ordinary combustion. It should also be noted that evidently no buildings are required for the steel plant, as none are provided for.

The Conley furnace, illustrated in the prospectus, is of the resistance variety and extremely simple. There is a bowl surrounded by a belt or zone of material of low electrical conductivity and a funnel-shaped furnace shaft above, having at each side of its lower end or throat a plate of similar material as used for the zone of the bowl, and a third plate dividing the throat into two equal parts. A strong electrical current sent through these plates will heat them to incandescence, and the ore will readily be melted at the throat and prevented from chilling by the heat of the zone. So the prospectus states at least.

With the enormous variety of electrical furnaces, descriptions of which have been published in the books of Moissan, Borchers, Duerre, etc., in the transactions of societies, in the engineering press and in catalogues, it is hard to see where the improvement lies that is covered by the Conley patents, except in some trifling detail of shape or arrangement. However, the prospectus says:

This company is operating under the Conley patents, which cover the apparatus, the process and everything essential pertaining to it. It is the pioneer electric steel company of the world. In view of the fact that it can make steel cheaper than anyone else, it is confidently believed that the eventual business of the company will be enormous and that the first investors will reap splendid results from their investment.

The most interesting part of the prospectus is the cost of production and profits. The cost per electric horse power per year and for 24 hrs. per day is given at $15, which is quite reasonable. The ore is to be obtained in the northern part of New York state and is to contain 65% of metallic iron, but it is more than doubtful if such ore could be readily obtained in that vicinity and at the price of $3.50 per ton, delivered at Massena. The coke required for the reduction of the ore is given at 0.15 ton per ton of ore and the price at $4 per ton of coke, delivered at Massena.

The table of cost is based upon a production of 100 tons of steel in 24 hours and 300 working days of 24 hours per year.

Electric current, per day	$208.33
30 tons coke at $4 per ton	120.00
200 tons, 65% ore, at $3.50 per ton	700.00
Renewals per day	50.00
Labor	125.00
Other expenses	50.00
Total per day	$1,253.33

Or $208.33 for power and $1,045 for all other items. From these figures it will be seen that one ton of steel is to be produced per day for every 41.7 HP. The profits are to be as follows:

Cost per ton of steel ingots at furnace	$12.53
Market price at present	28.00
Profit per ton	15.47
Profit per year (on a capital of $100,000)	464,100.00

The prospectus comments thereon: "The estimated profits will strike the investigator as being tremendously large, but it must be borne in mind that this process of making steel is not simply an improvement in the art, but it is a revolution in the method of steel making."

In Engineering News of Oct. 2, it is stated that 78 KW. of electric current produced 575 lbs. of steel per 24 hours. Then 362 electrical HP. would produce 1 ton in 24 hrs. Applying these figures (from actual practice) to the above tables of cost and profit, and neglecting the fact that the Swedish ore requires less current than the American, on account of its greater purity, we have:

Electric current (at $15 per HP. per year) per day	$1,810.00
All other items, per day	1,045.00
Total per day	$2,855.00

The profits now become a negative quantity, as we have:

Cost per ton of steel ingots at furnace	$28.55
Market price at present	28.00
Loss per ton	0.55
Loss per year	16,500.00

That is, instead of a profit of 464% we have a loss of 16½%. The prospectus closes with the following statement "It is expected that within three months the company will be turning out steel commercially."

We have not seen any of this electric steel yet, although the prospectus was issued eight or ten months ago.

Yours very truly, John W. Thurso.

75 Common St., Montreal, Canada, Oct. 27, 1902.

[In our issue of May 2, 1901, we showed that one horse power of electric current acting continuously for a year with perfect efficiency upon an almost pure iron ore could reduce at the very best only 2¾ tons of ore to metallic iron. With electricity at $15 per HP. per year it follows that a theoretically perfect furnace would consume $5.45 worth of electricity per ton of ore reduced. We need hardly make any comment upon the prospectus figures of the Massena Electric Co. wherein we see that they propose reducing iron ore by using only $1.04 worth of electricity per ton of ore, against which our correspondent's figures of $18.10 worth of electricity, based upon actual results in Sweden, stand out in sufficient relief.—Ed.]

Notes and Queries.

Mr. Geo. W. Rafter writes that there are over 100 rainfall observation stations in New York state. In a discussion at the Rochester meeting of the American Society of Municipal Improvements, reported in our issue of Oct. 16, Mr. Rafter stated offhand that there were 60 such stations.

T. C., Chicago, Ill., asks what is the heaviest weight of rail used on railways in this country.

The heaviest rails weigh 100 lbs. per yd. Rails of this weight are used on numerous railways, not for their entire length, but on portions having the heaviest traffic. On some street railway lines still heavier rails of the girder type have been used.

THE JOHN FRITZ DINNER.

It was a notable assemblage that met in the grand banquet hall of the Waldorf-Astoria Hotel in New York city on the evening of Oct. 31 to celebrate the 80th birthday of John Fritz and the founding of the John Fritz medal. The company included many of the leading iron and steel manufacturers of the country, several representatives of the army and navy, more than three hundred members of the four national engineering societies and nearly a hundred ladies, the total numbering over five hundred. The spacious room was arranged with a long table at one end for the speakers and a few distinguished guests, and 55 large round tables, each seating six or eight, giving a total seating capacity of 410, which was fully occupied by the men, while the ladies filled the boxes in the balcony. It was altogether the most magnificent banquet ever given by engineers in this country, and in every way a most memorable event in the history of the profession.

To go back ten years, when Mr. Fritz was then general manager of the Bethlehem steel works, which had but a short time previously completed its new plans for the production of fluid compressed steel for armor plate, guns and forgings, a small party of his friends met in the Engineers' Club and agreed to give him a dinner in Bethlehem to celebrate his 70th birthday. A hall was engaged and notices were sent out to members of the engineering societies, iron and steel manufacturers and others of his friends inviting them to subscribe to the dinner. Applications for seats came rolling in to such an extent that it was found expedient to engage a larger hall, but before the day appointed it was found necessary to engage the armory, the largest room available in Bethlehem, to accommodate the host of friends, between three and four hundred, who wished to do him honor.

That was also a memorable occasion. The after-dinner proceedings were unique and consisted chiefly in a mock trial, in which Mr. Fritz was prosecuted for the heinous crime of having during his many years' residence in the Lehigh Valley converted it from a peaceful country landscape into a hideous agglomeration of iron and steel works, railroad tracks, cinder banks, smoke, etc. One of the events was the presentation to Mr. and Mrs. Fritz of a splendid "grandfather's clock." The morning after the banquet was spent in a trip through the Bethlehem works and a visit to the gun-proving ground a few miles distant, to see Bethlehem guns tried against Bethlehem armor plate.

Now, ten years afterwards, a still larger company has met to do Mr. Fritz like honor. The banquet was not so much a tribute to Mr. Fritz as a great leader in the world's steel industry as to the personal character of the man. One of the most modest and unassuming of men, he has ever been the friend of capitalist and laborer alike, and the friend of every young engineer who has ever been fortunate enough to make his acquaintance.

The decorations of the room and the tables were symbolic of the iron and steel industry. A model blast furnace was in one corner and an open-hearth in another. Table pieces were made representing ships of war, guns, bridges, locomotives, etc., and the sherbet was served in boxes made to look like short sections of steel rails. The menu was contained in a large pamphlet, bound in metal-coated paper, held together by bolts and rivets, and embossed with a representation of a blast furnace. Within, on parchment paper, it contained an engraving in sepia tint showing the

Bethlehem works, a blast furnace, a rolling mill, etc., and an excellent photograph of Mr. Fritz, with his autograph signature, also the menu card, with the symbols of the four national engineering societies, the programme of exercises, and a poem by Dr. R. W. Raymond, which is as follows:

JOHN FRITZ.

Whom shall we choose, the flag to hold
In our vast conquest, yet untold,
Which to the New World adds the Old,
Donner and Blitz!
John Fritz.

Leaders unseen are with us met,
Nor they nor we the past forget!
The fate that took them early, yet
Thank God, omits
John Fritz.

Who stands before us to combine
A level head, an upright spine,
With nowhere any crooked line?
Most clearly it's
John Fritz.

Whose heart is warmer than his blast?
Whose faith more steadfast to the last
Than any steel he ever cast.
That figure fits
John Fritz.

Whose fame commands our homage, such
As bears of envy not a touch
Because we love the man so much?
Why, there he sits,
John Fritz.

On worthy breasts henceforward let
This token in his name be set,
A kingly name as ever yet
Signed royal writs,
John Fritz.

The programme of exercises was as follows:

Salutatory. Henry Goslee Prout, C. E., M. A., Toastmaster.
Presentation of the Medal. John Thomson, C. E.
The Fathers of the Art. Hon. Abram S. Hewitt, LL.D.
The Navy. Rear-Admiral George W. Melville, U. S. N.

THE JOHN FRITZ MEDAL.

The Army. Brig.-Gen. Eugene Griffin, U. S. V.
Messages of Congratulation. Chairman Dinner Committee.
The American Society of Civil Engineers. George Shattuck Morison, C. E., M. A.
The American Institute of Mining Engineers. Dr. Rossiter E. Raymond, E. M.
The American Society of Mechanical Engineers. Capt. Robert W. Hunt, C. E., M. E.
The American Institute of Electrical Engineers. Prof. Elihu Thomson, E. E.
The Valley and the Neighbors. Oliver Williams.
John Fritz's Old Boys. Daniel A. Tompkins, M. E.

When the after-dinner coffee and cigars had been served, Col. Prout opened the exercises by his salutatory, which was as follows:

We are met to celebrate two events; first, the eightieth birthday of our friend, John Fritz; second, the successful founding of the John Fritz Medal. If I might borrow for a moment the thought of the immortal Gettysburg speech, I should say that Mr. Fritz has already anticipated this celebration and made it superfluous by his great and lasting gift to the happiness and prosperity of mankind, and by his simple, dignified and sincere life. It is little that we can add to the esteem in which he is held by those who know him well. It is little that we can add to the glory of his name throughout the world. It is little that we can add to the life of the monument that he has built for himself. But we can find pleasure in expressing to him our admiration and our affection. We can get inspiration and a glow of enthusiasm for our own lives in the words of those who know his work and his character. Those are the real reasons why we are here.

The General Committee has directed me to say a word about the John Fritz Medal, its origin, its purpose, and its state. The story is short. A few friends proposed to celebrate Mr. Fritz's eightieth birthday. Then they thought to establish a memorial of his life and work. A medal, to be given each year in recognition of eminent work in research or in applied science, seemed to them the most appropriate memorial. They decided to make each individual subscription small, that many men might share in it. They wished that the medal might be like the olive wreath in the Olympian games, a little thing, provided at trifling cost, but a sign of glorious achievement; something that a man would put among the most precious trophies of his life. They provided for a permanent and dignified committee of award, to represent the four great engineering societies of this nation. They provided that the medalists shall be chosen from all the world. They believe that considering the field of effort which it covers and the manner in which it is awarded, the Fritz Medal will be even a more dignified honor than the Bessemer Medal, which Mr. Fritz and Mr. Hewitt are proud to hold. The Medal is provided for, the die is made, and the first award will now be announced.

Mr. John Thomson then presented Mr. Fritz with a large album and with two bronze casts, obverse and reverse, of the original model, 7 ins. in diameter, of the Fritz medal. Following is his address:

Mr. Fritz: We have thought it would please you to have a permanent record in respect to the founding of the medal which bears your name.

I have here an album; it contains a photograph of yourself; also photographs of the obverse and reverse of the medal, under which is this excerpt from the rules for the award: "To perpetuate the name of John Fritz and his achievements in industrial progress." The dedication is "To John Fritz, Engineer, One of the Principal Founders of America's Iron and Steel Industry." Besides the historical data, it also contains the names and addresses of the founders, and their autographs, 484 in all, of world-wide distribution.

In behalf of the founders of the John Fritz Medal, I have the great pleasure to present you with this album, asking that you accept it, and that for which it stands, as a testimonial of our admiration and regard; and we would have you believe that we desire no higher honor than to be known as friends of John Fritz, of Bethlehem.

We have also thought that it would add to your pleasure to announce, especially upon this occasion, the first award and the name of the recipient of the first medal.

The rules relative thereto, adopted by the committee, seem to indicate, at this time, but one name in that the stipulation is expressly set forth that the award shall be made to commemorate the most notable scientific and industrial achievements.

These plaster patterns, which I have received from the hands of the artist, were reproduced from the enlarged scale clay models, from which one duplicate set have been cast in bronze. But no other duplicates will ever be made therefrom; for these master-patterns shall now be destroyed.

I am duly authorized and directed to make the following official announcement of the award: We ask that you, John Fritz, accept these bronzes, the first John Fritz Medal, the only one of its kind which will ever be presented, as an award made by and coming directly from the founders; our unanimous finding being that, of all the Captains of Industry, this medal may most worthily be bestowed upon you. We beg to assure you of our abiding belief that the crowning reward of your splendid achievements and character will be the perpetuation of your name, an inspiring ideal for the Engineering and Industrial Captains of the future. And now, we, the founders of the John Fritz Medal, heartily wish you many long and happy years, and growing honors, and the love of friends.

Mr. Fritz then accepted the medal in the following words:

Standing here, my mind is carried back to the days of my youth when working on the farm, from sunrise to sunset, barefooted, as farmer boys did at that time; things the wildest imagination could not have foreseen this day. I appreciate this greeting, and accept it as a token of your esteem, and am truly sensible of the great honor you have thus conferred upon me, which gives rise to a sincere joy in my heart, that takes precedence of all other emotions, and I can only say that I thank you from the depths of my heart.

But what have I done to earn this reception? Why, little I have done has been much overrated, and I am the recipient of honor beyond what I deserve; but I hope that my kind friends will continue to overlook my shortcomings, as I have ever tried to do my best. I do not forget my loyal assistants and the laboring man, and especially the able, brave and noble men who loyally stood by me in times of the severest trials that were encountered during my long connection with the iron and steel industries, and who were ever ready to face any hardship or danger that would in any way tend to prevent success. To these kind and loyal men much credit is due for such success as I have attained. But, alas, the majority of them have gone, the grave has closed over them, but they are not forgotten, and they will ever have a green spot in my memory.

It was my misfortune to start in the world with a meager education; the schools in the neighborhood where I was raised were of the most primitive character, being before free schools were established and before trained teachers were employed. They were only kept open about three months in the summer, when the girls generally attended, and about the same time in the winter for the boys, they having to work on the farm in the summer and a great part of the spring and fall months, so it was only possible to get the simplest education.

I was born of exemplary parents; my father being a man of high moral character, he fully impressed upon my mind the importance of energy and economy, and absolute integrity. My mother was a true, Christian woman, and early taught me to read and revere the Holy Bible, and to trust in the Supreme Being, and that to respect and obey His laws, was a duty which mankind should not disregard. At this distant day, to my mind, the moral and religious training received from my parents, and their noble example, was the most important training I could possibly have received, and I have ever thought the highest honor I could pay to their memory was to endeavor to follow their noble example.

In after years, when overburdened with grave responsibilities, which were ever recurring, and had to be met, it was then I sorely felt the want of a better education, but on reflection I knew my parents had done the best they could and I was content. It has always been my good fortune to be blest with many kind and loving friends, who have stood by me in the darkest days, and were ever ready to give assistance by their wise and sympathetic counsel.

There are times when it is an agrreable servitude to be under obligation to those whom you esteem, and I am deeply sensible of the honor conferred upon me on this occasion, and greatly regret that I have not the command of language to make a fitting acknowledgment to my kind friends who have provided for the "Fritz Medal," and arranged this splendid birthday feast, and to you all for your presence here to-night. But no words of mine can ever express the full measure of gratitude that I so deeply feel towards you all. And here, my dear friends, I beg to assure you that the uniformly kind and thoughtful attention that you have always shown me will be held in grateful remembrance.

May God, in His infinite Mercy, vouchsafe to you all, long, useful and happy lives, surrounded by kind and loving friends, is my most fervent desire.

Mr. Fritz's remarks were of course received with the utmost enthusiasm, and at the end the company rose, as one man, and with waving of napkins started singing "For he's a jolly good fellow," which the band then played.

Mr. Abram S. Hewitt, who is also an octogenarian, was not able to be present, but he sent a letter, which was read by Mr. T. C. Martin as follows:

As you are aware, I have been debarred for some time by the limitations of age from assisting at any function which takes place in the evening. I have been trying, however, to make an exception in favor of the complimentary dinner given by his admirers to my old and valued friend, John Fritz; but now that the time has arrived, I find I must deny myself the pleasure of personally congratulating him, in the company of his loving friends, upon the attainment of his eightieth birthday in the full possession of his health and faculties, and with the promise of many honorable years to come.

We have made the journey of life together, and to some extent upon the same lines of action. It is pleasant to recall that, during the half century of our association, at times of competitive struggle, the friendship which has

existed between us has never in the slightest degree been disturbed. This happy experience is due doubtless to the amiable traits of Mr. Fritz's nature, which, with all its masculine energy, is tempered with the sweetness of the gentler sex. "Once a friend, always a friend," will be inscribed upon the record of a career, which, in some respects, is unique among the men of our day and generation.

I do not intend to indulge myself in recounting any of the interesting details of his long and useful life. This pleasant duty will be performed by others, but I do desire to point out that the life work of John Fritz affords a very conspicuous example of the working of American institutions during the century which has just closed, the most remarkable era of progress in the history of the human race. That a boy, born in humble life, with no advantages of education or opportunities for position, without influential friends, or the favoring accidents of fortune, should be able to advance steadily in usefulness, power and the respect of his fellow men, until by common consent he occupies the first place in the domain of the practical industry with which he has been connected, gives conclusive evidence that political institutions which afford free play to individual ambition, industry, ability and strict integrity, are worthy of all loyalty and should be cherished and preserved at all costs and hazards.

The developments of the Twentieth Century show that these institutions are in great peril. Their essence is to be found in individual liberty, involving the right of free labor and the acquisition of private property under lawful conditions. When the right of free action shall be suppressed, the possibility of a career like that of John Fritz will be destroyed. Collectivism ending in socialism may afford other advantages, but let it not be overlooked that these advantages will be obtained only by the sacrifice of personal freedom, and will arrest the progress of civilization due during the ages that have passed to the substitution of freedom for force.

John Fritz is a living proof of the results of individual and industrial liberty, in a country endowed with boundless resources. In vain shall we seek for a like career in nations or in countries where the individual initiative has been suppressed. The stagnation of China, whose men are physically strong, and whose resources are abundant, is in marked contrast with our own land, where heretofore every citizen has been free to employ his labor and his energies in his own way, so long as the rights of others are respected.

John Fritz, therefore, is to us more than a man whom we love and respect, more than a friend to whom we wish many years of health and happiness; he is an example of the free spirit of American institutions, a beacon light warning the present and coming generations against permitting any invasion of the principle of the liberty of the citizen, which alone has made our beloved country great and free.

The striking passages in Mr. Hewitt's address were received with great applause.

Addresses were then made by Admiral Melville and General Griffin, setting forth the great value of Mr. Fritz's services to the Navy and to the Army. Mr. Martin then announced that he had received a great stack of letters, telegrams and cablegrams from all over the world, but that time would permit of his reading only a few of the cablegrams. Mr. Carnegie's message from Scotland was as follows:

Absence deeply regretted. Long life, happiness, health, wealth, and honor to John Fritz, rolling mill pioneer, friend and counsellor of us all.

Cablegrams were also read from England, Wales, Belgium, Germany, Italy and Japan. The one from Italy was said to be from the foremost ironmaster in that country. It was from Charles M. Schwab, President of the United States Steel Corporation, who is now there recovering his health. Mr. Irving M. Scott, of the Union Iron Works, San Francisco, sent the following:

To John Fritz on his eightieth birthday. The Builder of the West greets the Genius of the East. The Oregon's performance glorifies the Steel of Fritz.

Mr. Scott also sent a large silver loving cup, which was duly presented to Mr. Fritz.

The veteran engineer, Mr. Chas. H. Haswell, now over 90 years of age, was at the speaker's table, and he made a brief speech. Speeches were also made by Mr. Morison, Dr. Raymond, Capt. Hunt and Prof. Thomson, representing the four engineering societies. Capt. Hunt's speech was especially notable, as he was one of Mr. Fritz's "old boys." He paid a great tribute to the memory of George Fritz, a brother of John Fritz, and a brilliant engineer, who died many years ago.

Mr. Oliver Williams then spoke for "The Valley and its Neighbors," the Valley being that of the Lehigh, where for many years Mr. Williams and Mr. Fritz have been near neighbors.

The last speech was by Mr. Daniel E. Tompkins, of South Carolina, on "John Fritz's Old Boys," of whom he was one. He has the southern gift of oratory, and his address was worthy of the occasion. When he made a reference to Mrs. Fritz, who was seated in the balcony, the audience rose and cheered. She is a well-preserved and handsome old lady, and showed plainly that she was delighted with the tribute paid to her.

It was after midnight before the exercises were over, and then there was an informal gathering for handshaking, which lasted an hour longer. Mr. Fritz's hale and hearty appearance were much commented on, and many were the expressions of wishes that his ninetieth birthday may be celebrated in like manner as his eightieth.

NOTES FROM THE ENGINEERING SCHOOLS.

UNIVERSITY OF VERMONT.—Prof. A. W. Ayer has resigned to accept the position of mechanical engineer with Harrison Bros. & Co., Inc., of Philadelphia. Mr. Edward Robinson, Professor of Mechanical Engineering at the Clarkson School of Technology, has been appointed to fill the chair of Mechanical Engineering left vacant by Prof. Ayer. A new and larger foundry and a new forge room with 20 down-draft forges have been recently added to the equipment of the University.

COMPARATIVE MERITS OF CONCRETE AND RUBBLE MASONRY.

In "The Rose Technic" for October, Mr. J. F. Montgomery gives a number of interesting facts about concrete which although not entirely novel will bear repeating.

The enormously increased capacity of American cement plants has brought the price of the best grades down to one-third what it was ten years ago. The increase in capacity has been 50% per annum for several years past. During the last few months there has been a cement famine, the price advancing 75% in 75 days.

The first cause of this demand is the almost universal adoption of concrete by the railroads for all heavy masonry. Cement dealers say that the western railroads have used several times as much cement this year as they did in 1901. One eastern road placed orders for 1,000,000 bbls. to be used this year.

The second cause of the increased demand has been the shortage of structural steel, resulting in a substitution of concrete in many places.

Many concrete buildings are being erected. In Cincinnati there is building a 15-story office building with foundations, footings, walls, columns, girders, and floors of concrete, reinforced with steel rods and bars.

The practical use for stereotemy is becoming yearly more contracted, so that probably ten years hence it will make little difference whether or not the engineer can design the templets for the keystone of a skew arch, so long as he is able to design a concrete arch for the same place.

It is probable that within another decade, rubble masonry will be considered in the same class with the log cabin.

This last statement appears to be rather unfounded, however, for rubble masonry will long remain an economical material for "backing," and we think it will never be entirely displaced by concrete for many classes of light walls.

Rubble masonry to begin with does not require a rock crusher, which, for work situated at some distance from a crusher, will make the rubble cheaper in so far as the cost of the stone is concerned.

Rubble masonry has considerably less voids than concrete, when the rubble is of large stones laid with joints well filled with spalls. This is strikingly shown by the fact that on the Erie Canal where Medina sandstone was used, laid in 1 to 2 Portland mortar (packed measure), only 0.63 bbl. of cement was required per cu. yd. of rubble, as compared with 1.06 bbls. of cement required in 1-2-5 concrete. Thus we see that the mortar item is considerably less for rubble, generally 0.4 bbl. of cement being saved per cu. yd. of masonry. Finally we have left the cost of laying. It is no uncommon thing to hear engineers speak of the cost of concrete making being so much less than masonry, because of the cheaper class of labor required. As a matter of fact rubble is ordinarily laid at about the same cost as concrete, so far as the labor item is concerned, for it is exceptional that a laborer will mix, lay and ram more than 2 cu. yds. of concrete in a wall, or 3 cu. yds. in a foundation pavement in 10 hrs., at 15 cts. per hr., making the cost of labor 50 to 75 cts. a cu. yd., generally the latter in wall work. On the other hand, in laying light walls where a derrick is not used, a mason at 30 cts. an hour and a helper, mixing mort., etc., at 20 cts. an hour, will roughly scabble and lay a good wall at a cost of about $1.00 per cu. yd., the two men thus laying ½ cu. yd. per hour.

It very frequently happens, and especially is this so with light walls, that the cost of putting up frames for concrete much more than eats up this difference of 25 cts. a cu. yd. between the labor items of rubble and concrete.

While concrete is much cheaper than cut stone for face work, it is evidently not infrequently more costly than rubble for small rough walls and backing. There is, moreover, another advantage possessed by rubble, in that a substantial rubble wall can be got with much less careful inspection than an equally substantial concrete wall; and this, too, is of especial importance where the work is so light that it will not pay to keep an inspector constantly on duty.

COKE MANUFACTURE FROM COMPRESSED SLACK.

The idea of compressing coal for coking purposes originated in Europe, where the fact was observed that the coke from the lower part of the ovens was denser and better, due to compression by the superincumbent charge, which led to experiments in artificially compressing the coal. In the Journal of the Iron and Steel Institute, Mr. John H. Darby outlines the process, illustrating the same with drawings. At the recent New Haven meeting of the American Institute of Mining Engineers,* Mr. Christopher G. Atwater, in his paper on "The Development of the By-Product Coke Ovens in the United States," also gave some information of the subject of compressed fuel. Mr. Darby believes that it would pay to compress even the best grades of coking coal, while Mr. Atwater believes that only the poorer coking coals should be compressed, as to drive off the water used at the time of compression consumes fuel, adding to the cost of production.

Mr. Darby says:

Generally speaking it was found that the weight of a given bulk of compressed fuel in an oven was 50% greater than fuel charged in the ordinary way. Taking into account the side clearance that has to be allowed in introducing a cake of fuel into an oven, the net gain in weight of an oven charge varied from 25 to 30% in favor of compressed fuel. But it was found that the compressed fuel coked more slowly than the uncompressed, and the net gain in production of coke per oven finally amounted to between 10 and 12% in favor of the compressed charge.

In the case of three samples from Durham the average weight for uncompressed coke was 63.4 lbs., and for compressed coke 88.9 lbs. per cu. ft.; for North Welsh uncompressed, 56 lbs., and for compressed, 60.6 lbs. per cu. ft.; South Yorkshire, uncompressed, 53.9 lbs., compressed, 57.9 lbs. per cu. ft.; for West Lancashire, uncompressed, 58 lbs., compressed, 66.4 lbs. per cu. ft. From which the average gain in weight of coke by using compressed coal was 20%.

Other advantages of compressing the fuel were: (1) Very small per cent. of breeze or smoke coke, and a stronger coke; (2) Time in charging the ovens lessened so that in one case the gases thereby saved yielded 25% more ammonia; (3) Less labor in charging. With the omisssions characteristic of so many similar papers, we cannot judge of the added cost of producing the coke due to the use of a plant for compressing the fuel.

The best plant for the purpose of compression is one that yields an almost continuous output of the compressed fuel. A long compression chamber receives the fuel from a traveling trough which deposits a layer. Following the moving trough is a leveler and a reciprocating stamp or hammer, mounted on a traveling carriage, deriving its power from an electric motor. Since the trough and stamp are continuously traveling back and forth along the box in which the fuel is being compressed, it is evident that the pro-

*Reported in Engineering News, Oct. 23.

cess is practically continuous until the box is fully charged.

In the long discussion that followed the reading of Mr. Darby's paper it was stated that the fine coal contained about 10% of water, which is the amount ordinarily found in washed coal.

THE COST OF WIRE ROPE HAULING IN ENGLISH COAL MINES.

Mr. Sydney F. Walker, of London, England, in "Mines and Minerals," gives some brief data relative to the cost of wire rope underground haulage. "Incidentally," he says, "the proper method of laying up wire ropes was not discovered until wire ropes had been in use for a long time," for the old method of giving a sharp twist to hemp ropes was blindly and foolishly followed for years in making wire ropes. Finally it was found that with wire rope the smaller the amount of twist the better the work and the longer the life of the rope. Without going into a detailed description of the methods of hauling coal cars with ropes, we may briefly state that there are three: First, the endless rope system similar to our American street cable car roads of the recent past; second, the "main and tail rope system," where the main rope serves to pull a loaded train out, and the tail rope serves to pull the empties back; third, what might be termed the single rope system for balanced haulage, used, for example, on inclines where the loaded car pulls the empty up.

The total cost of operating a rope haulage system is not easily ascertained; it is made up of five principal items, (1) the cost of power required in overcoming the friction produced by the rope itself as it passes over pulleys and rollers; (2) the cost of power in moving the cars and their loads; (3) the attendance of men handling the cars; (4) the cost of the rope itself spread over the total ton mileage of coal moved during its life; and (5) incidental repairs.

Mr. Walker puts the cost of wire rope haulage in England at 4 to 5 cts. per ton-mile, and the cost of chain haulage at 2 to 3 cts. per ton-mile.

Since nothing is given in the way of details to substantiate these figures, we repeat them only because they are somewhat better than no data at all, and because they illustrate how not to write an engineering paper. If Mr. Walker's conclusions were not more than a guess he should at least have given the items that go to make the 4 or 5 cts. per ton-mile; moreover, he should have given the wages of labor, the cost of the ropes and their length, and the price of coal used for power.

Otherwise good contributions to engineering literature are often rendered of little value because of such omissions. Not infrequently a very elaborately detailed article on costs does not contain the very unit upon which the costs are based, namely, the rate of wages per hour.

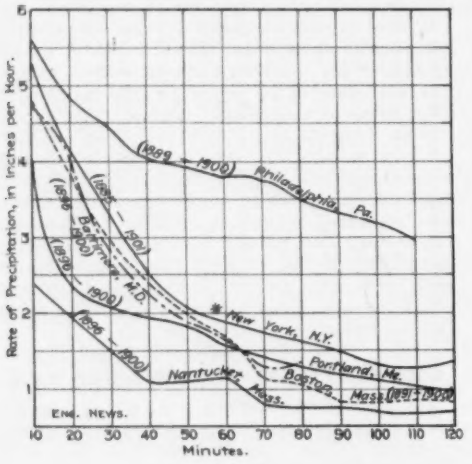


Fig. 1.

*Data from N. Y. Meteorological Observatory.

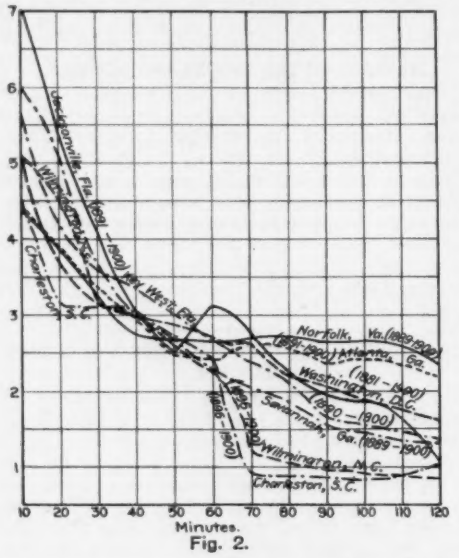


Fig. 2.

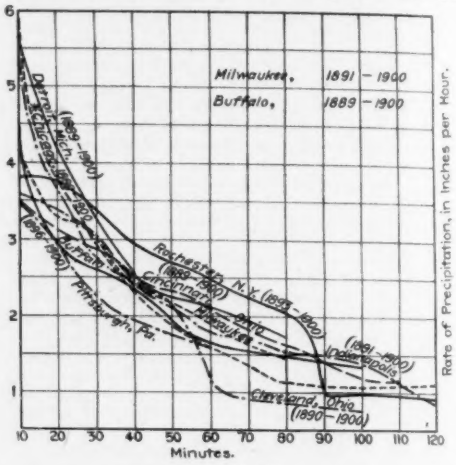

Rate of Precipitation, in Inches per Hour.
Minutes.
Milwaukee, 1891 - 1900
Buffalo, 1889 - 1900
Detroit, Mich. (1899 - 1900)
Chicago, Ill. (1890 - 1900)
Rochester, N.Y. (1895 - 1900)
Cincinnati, Ohio (1892 - 1900)
Toronto, Ont. (1892 - 1900)
Pittsburgh, Pa. (1890 - 1900)
Indianapolis, Ind. (1891 - 1900)
Cleveland, Ohio (1890 - 1900)

Fig. 3.

*1898-1899 missing.

FIGS. 1-5. DIAGRAMS SHOWING MAXIMUM PRECIPITATION IN VARIOUS CITIES FOR PERIODS OF 10 TO 120 MINUTES.

(Data from U. S. Weather Bureau and (for New York) from New York Meteorological Observatory. The years given are both inclusive.)

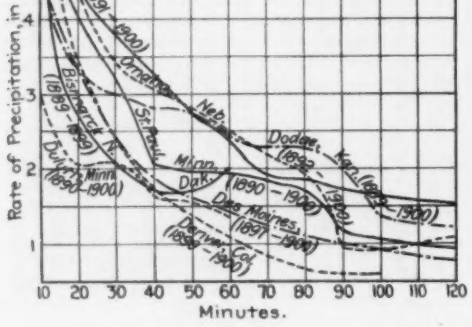

Rate of Precipitation, in Inches per Hour.
Minutes.
Kansas City, (1891 - 1900)
Omaha, Neb. (1895 - 1900)
St. Paul, Minn. (1891 - 1900)
Dodge, Kan. (1892 - 1900)
Black Hawk, S.D. (1891 - 1900)
Duluth, Minn. (1890 - 1900)
Dak. (1890 - 1900)
Des Moines, Ia. (1891 - 1900)
Denver, Col. (1898 - 1900)

Fig. 4.

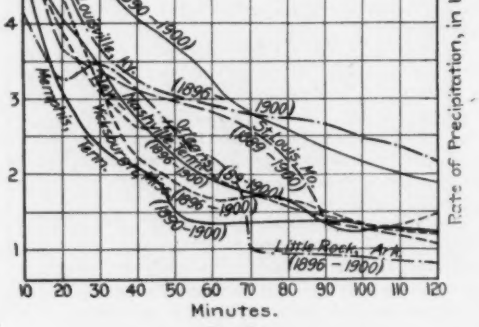

Rate of Precipitation, in Inches per Hour.
Minutes.
Galveston, Tex. (1890 - 1900)
Louisville, Ky. (1890 - 1900)
Memphis, Tenn. (1890 - 1900)
Nashville, Tenn. (1896 - 1900)
Knoxville, Tenn. (1896 - 1900)
Atlanta, Ga. (1890 - 1900)
Augusta, Ga. (1896 - 1900)
Vicksburg, Miss. (1896 - 1900)
St. Louis, Mo. (1889 - 1900)
Little Rock, Ark. (1896 - 1900)

Fig. 5.

STORM FLOWS FROM CITY AREAS, AND THEIR CALCULATION.

By Ernest Wilder Clarke.*

In designing any member of a system of sewers which is required to carry off surface water, the most important factor in determining the size of the sewer is the amount of such water it must be able to discharge without backflooding the area. The maximum sewer grade possible, and the area drained, are easily found, and then the maximum cubic feet per second of flood water (Q) must be estimated before the size of the proposed sewer can be fixed. Having frequently had occasion to make such designs, I have been impressed by the difficulty of calculating Q within reasonable limits by means of accepted formulas.

*40 North Parsons Ave., Flushing, L. I.

Mr. Emil Kuichling, in a paper read before the American Society of Civil Engineers, in 1889, proposed a method of finding Q which does away with much of the uncertainty due to depending on formulas deduced from gagings of storm flows from city areas. Such formulas doubtless represent very faithfully the flow from the particular area or areas on which they were based, but the difficulty in applying them to other areas lies in the number of factors affecting the storm discharge. These formulas are, and must be, empirical, and when the effect of the shape of the watershed and the character of the pavements and other surface conditions are expressed by either a single coefficient or by powers of the constants, the application of the formula is really restricted to the area from which that coefficient or powers were deduced, whether the area be urban, suburban or rural. Not only the coefficient, but also the proper value of the rate of rainfall, is partially dependent on some of the constants of the original area, and it by no means follows that equal runoffs from equal areas would be due to equal rainfalls, even if practically the same surface conditions existed in each. The shape of the watershed would still be a factor in the problem, and must be considered in any determination of Q that would pretend to even approximate accuracy.

Mr. Kuichling's method has been elaborated and discussed by Walter C. Parmley (Jour. Assoc. Eng. Socs., March, 1898); Prof. H. N. Ogden, of Cornell University ("Sewer Design," 1899); Prof. Arthur N. Talbot ("Technograph," Univ. Ill., 1891-1892); and Rudolph Hering and S. M. Gray ("Baltimore Sewerage Commission Report," 1897); and the present paper is intended as a plea for the use of this rational method. The argument, of necessity, follows much the same lines as those of the previous discussions, but with some variations which appear to render the method more accurate. Absolute accuracy in the determination of Q is, of course, impossible; but the engineer owes it to himself and to his profession that the sewer he recommends shall be able to perform the duties for which it is intended, or, if knowing it to be liable to occasional backflooding, he should be able to state how often this will probably occur, and to give good reasons why it should be allowed.

USUAL FORMULAS.—The formulas usually employed in computing storm flows are the following:

Hawksley, $Q = C \sqrt[4]{r^3 A^2 S}$;

Buerkli-Zeigler, $Q = C\, r\, A \sqrt[4]{\frac{S}{A}}$;

McMath, $Q = C\, r \sqrt[5]{S A^4}$;

Adams, $Q = C\, r^{1/2} A^{5/6} S^{1/12}$;

New York, $Q = C\, r\, A^{.95} S^{.15}$.

Where Q = discharge of area in cu. ft. per sec. r = max. rainfall in inches per hr. A = area of shed in acres. S = average slope of shed in feet per thousand. C = a coefficient.

The fundamental error of these formulas is that they all make Q independent of the shape of A. According to the formulas, a long narrow shed and a short broad one of equal area give equal discharges, while it is almost an axiom to say that they do not.

The papers before referred to call attention to the large influence on amount of storm discharges, of "the time of concentration," which may be defined as the time required for water to flow through the sewers from the most distant inlet to the sewer under design, which sewer, for convenience, we will call A—B. It is self-evident that by the time this water has reached A—B, water is also passing which fell on all the rest of the area; that is, at that moment the whole area begins to contribute.

In all flood discharges there must be a moment when the flood crest in the sewer is reached, before which the flow is increasing, and after is diminishing.

Assuming that the whole shed has a practically uniform slope, this crest occurs when the total area drained begins to send its water through A—B, for previous to that moment a steadily increasing portion of the shed was being drained by A—B, and after that time, though the area contributing remains constant, the rate of precipitation is decreasing, and hence, the runoff. The "time of concentration" is, then, the time in which the flood crest will be reached after the beginning of the heavy precipitation. This may be calculated by figuring the velocities in the sewers (running at their designed depths), leading to the most extreme inlet and dividing their respective lengths by the velocities so found.

The water composing the maximum flood did not, however, all reach the ground at the same moment of time, some drops coming from distant parts of the watershed fell in the first moments of the storm, while others from parts quite near A—B fell a few minutes before the time of passage of the flood crest. As will be shown later, the rate of precipitation decreases as the time increases, so that the drops from the distant inlets were part of a heavier rate of rainfall than those from the less distant; therefore, the rate of rainfall actually causing the flood crest is not that corresponding to the time of concentration, but to some average time depending on the number of inlets and their method of distribution. The word storm, as used here, and elsewhere in the paper, means the period of excessive precipitation, and has no reference to the moderate rainfall that may have occurred before the heavy fall began.

Suppose the area to be divided into a number of zones, of such a size and so arranged that all the water falling on any one zone would reach the sewer A—B at the same time. Let t be the time of concentration in minutes; t_1 be the average time in minutes required for the passage of the water from the various zones to A—B; n be the number of zones, and $t - t_1$ the number of minutes to which the rainfall causing the maximum flood corresponds.

Then

$$t_1 = \frac{1}{n}\left\{t - \left\{1 - \frac{n}{n}\right\} t + t - \left\{1 - \frac{n-1}{n}\right\} t + t - \left\{1 - \frac{n-2}{n}\right\} t + \ldots t - \left\{1 - \frac{n-n}{n}\right\} t\right\}.$$

$$t_1 = \frac{1}{n}\left\{t + \frac{t\,n^2 - (1+2+3+\ldots n)\,t}{n}\right\}.$$

If

$$n = \infty,\ t_1 = \frac{t}{2}$$

Therefore, the rate of rainfall actually contributing to the flood would be that corresponding to one-half the time of concentration. This ratio is, however, merely theoretical, as the conditions of an infinite number of inlets is practically impossible, and also that all the water falling on a zone, however small, should reach the sewer at the same time.

Considering the rainfall curves (shown later) and the fact that the areas contributing to the actual inlets vary in size and shape, it seems probable, however, that to use $t = \frac{t}{2}$ would be a fair approximation of facts.

To make this whole argument more plain, suppose a fan-shaped system of four sewers, 0—1, 0—2, 0—3 and 0—4, joining at 0, and that their maximum combined flow is to be calculated. Suppose each sewer capable of discharging 10 cu. ft. per sec., and that the time of flow from 1 to 0 is 2 minutes, 2 to 0 is 4 minutes, 3 to 0 is 6 minutes and 4 to 0 is 8 minutes. Instead of a rainfall, suppose men stationed at the upper end of each sewer, who at a signal will cause 10 cu. ft. per sec. to be discharged into each sewer, and regularly reduce the flow to 8 cu. ft. per sec. at the end of two minutes, and so on, reducing 2 cu. ft. per sec. in each two minutes. At the end of two minutes from the first signal 10 cu. ft. per sec. would begin to flow by 0, and thereafter at the end of each two minutes interval the flow would be as in the following table:

Time.	Cu. ft. per sec. passing 0. From— 0—1.	0—2.	0—3.	0—4.	Total.
2 mins. after signal.....	10	..	..	..	10
4 " " "	8	10	..	..	18
6 " " "	6	8	10	..	24
8 " " "	4	6	8	10	28
10 " " "	2	4	6	8	20
12 " " "	..	2	4	6	12

That is, the maximum would be reached in 8 minutes from the first discharge, which is the same as the time required for water to pass through the longest sewer.

Dividing 28 cu. ft. by the number of inlets gives an average of 7 cu. ft. for each inlet. Applying n = 4 in formula (1), $t_1 = 5$, $t - t_1 = 8 - 5 = 3$ minutes, and 7 cu. ft. per sec. is the discharge into the inlets at the end of 3 minutes, according to our assumption. Of course, if this illustration were applied to a larger number of inlets the average flow would approach nearer to the mid-time discharge, but only at an infinite number of inlets would it ever reach it, and then only be true on the assumption of pouring the assumed discharges directly into the inlets.

Before the water reached the inlets it consumed some time in passing over the roofs, lawns and street surfaces. Mr. Parmley estimated this as eight minutes. I have no data to either criticise or confirm this estimate, but consider it a very fair one, and probably as accurate as any such constant can be—in any case, some allowance must be made for the time thus occupied.

The method of finding the time whose rate of precipitation would cause the maximum flood is then as follows:

(1) Estimate the time in minutes required for water to pass from the most distant inlet to A.

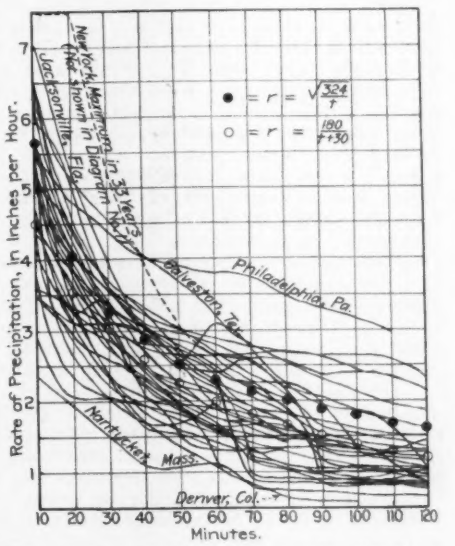

Rate of Precipitation, in Inches per Hour.
Minutes.
10 20 30 40 50 60 70 80 90 100 110 120
1 2 3 4 5 6 7
● = r = √(324/t)
○ = r = 180/(t+30)
New York, Maximum in 33 Years (not shown in Diagram)
Jacksonville, Fla.
Galveston, Tex.
Philadelphia, Pa.
Northfield, Mass.
Denver, Col.

Fig. 6. Diagram Showing Maximum Precipitation in 39 Cities, Being a Combination of Figs. 1 to 5.

(Designed to show the variation in intensity of rainfall for equal periods in different localities.)

(2) Take one-half of this time and add 8 minutes.

Mr. Parmley attempted to formulate the value of t as follows:

$$t = \frac{3.2\sqrt{A}}{S^{0.75}} + 8$$

This is based on a rectangular area whose width is one-third its length, and a velocity in the sewers of 1.5 ft. per sec. The introduction of these assumptions makes the formula only applicable to cases where the assumptions are true, or as an approximation when data regarding the contributing sewers is not available, and for the latter purpose it may be very useful.

DETERMINATION OF THE VALUE OF r.—Looking back again to the five representative formulas, we find in all a factor r, or rate of rainfall in inches per hour, and in using them the first question to be decided was the value of this factor.

It has been customary to select from the rainfall records of the locality the maximum, or sometimes a secondary maximum of frequent occurrence, for an hour, and to use this as a constant in figuring runoffs from all areas, regardless of their size, shape or slope. Previous to 1889, rainfall records for subdivisions of an hour were very infrequent, but since that date self-recording gages have been installed at many stations of the United States Weather Bureau, and the records of notable storms published in the reports of the Bureau.

The accompanying diagrams (Figs. 1 to 5) show the maximum storms in 39 cities according to these published records.

The method of obtaining these curves was as follows: The detailed records of the heavy storms occurring in a city were tabulated. Then the maximum precipitations for 10, 20, 30, etc., consecutive minutes were picked out for each storm regardless of their relative time of occurrence in the storm; finally the maximum for each 10 minute period for all the storms of the city were grouped as representing the maximum storm for that particular locality. The figures thus obtained were in cumulative inches of rainfall, and being reduced to their corresponding rates per hour were plotted on the diagram and the curves drawn. No such storm has occurred in its entirety, but the precipitation for each 10-minute interval has been recorded, and hence may be expected to occur again. It is of no present interest to us whether the entire grouping may or may not occur, but only what rainfall for $\frac{t}{2}$ may be expected.

In making these diagrams, maximum rainfalls were taken from 111 storms, or an average of nearly three storms to each curve. The maximum falls all occurred in 1 storm in 3 cities; 2 storms in 12 cities; 3 storms in 12 cities; 4 storms in 9 cities; 5 storms in 1 city and 6 storms in 1 city.

The New York city curve is based on the records of the New York Meteorological Observatory, which extend back to 1868. In the 33 years, but one storm has exceeded the curve shown. On Aug. 6, 1878, the fall was as follows:

	Time in minutes— 10.	20.	30.	60.
Cumulative fall, ins.....	1.25	2.50	2.65	2.66
Rate, per hour, ins.....	7.50	7.50	5.30	1.33

For long sustained precipitation, the storm at Philadelphia, Aug. 3, 1898, probably holds the record—the curve shown is all from that one storm.

"The most favorable conditions for the sudden condensation of a vast quantity of water vapor are conceived to be (1) strong vertical temperature gradient; (2) high surface temperature and humidity—in fact the general conditions of humidity and instability of the atmosphere necessary to the formation of thundrestorms and tornadoes." (Mr. Alfred J. Henry, U. S. Weather Bureau, Bulletin D, 1897, p. 62.) Common experience bears this out, and it is probably true that nearly all of these heavy rainfalls have accompanied thunderstorms.

Thunderstorms are almost always of small area and caused by local conditions—conditions which

possibly could not have occurred elsewhere in all their details, owing to variations of land and water surfaces. As far as the records go, there is no indication that equal precipitations are to be expected in cities even reasonably near to each other—in other words, the local conditions so affect the quantity of water vapor in the atmosphere that very different amounts are precipitated when the overturning of the atmosphere takes place. Each locality seems to be a law unto itself. At the same time, it must be remembered that the present records cover but a small number of years—but one over twenty years and many only four—and the future may show that in long periods, practically the same maximum storm is attained in all parts of well-defined areas.

Efforts have been made to formulate the rate of rainfall with t as a factor. Professor Talbot gives (using our own notation) $r = \frac{105}{t+15}$, where r = ordinary maximum rainfall, and $r = \frac{180}{t+30}$

where r = rainfall not exceeded in 15 years. Three formulas of my own, based on the parabola, also give results agreeing, within reasonable limits, with the records, when t is between 10 and 120 minutes. These formulas are:

$$r = \sqrt{\frac{324}{t}};$$

where r = rainfall in inches per hour exceeded but once in 15 years.

For rainfalls exceeded but once in 8 years

$$r = \sqrt{\frac{162}{t}};$$

while for rainfalls to be expected every year

$$r = \sqrt{\frac{54}{t}}.$$

These last two are good representations of the New York records especially.

Formulas for r are, however, of value only where records are not obtainable. A table of maximum, but draining areas whose time of conmade and plotted in the form of a diagram is more easily used and more accurate than any formula which must be based on the records of several localities to have more than local interest, and, therefore, not strictly applicable to any one place. The examples shown on the present diagrams are evidence of the fallibility of depending on formulas for rainfall. New York and Philadelphia were reasonably grouped together geographically, and yet the actual variation for 60 minutes has been almost 2 ins.

These records also show the necessity of varying r with t, and why sewers designed on a 60-minute maximum, but draining areas whose time of concentration is smaller than 60 minutes, may be subject to frequent overflowing. Having found t then by the method already outlined, the value or r in inches per hour, corresponding to ½ t + 8 should then be taken from the table or diagram for use in the equation for discharge.

CALCULATION OF Q.—The fundamental formula for the flood discharge in cubic feet per second is Q = rA, where Q = cu. ft. per sec.; r = rainfall in inches per hour; A = area in acres (using the well-known approximation, that a rainfall of 1 in. per hour falling on an impervious surface, will give a run-off of 1 cu. ft. per sec. per acre).

If a drainage area were absolutely impervious and evaporation for the short period of maximum flood flow be ignored, as it may be, the formula would represent the discharge within less than 1%, but the area is not necessarily impervious, and a coefficient must be introduced to represent the percentage of rainfall actually appearing in the runoff. Hence, Q = c r A,* where c = percentage of area regarded as impervious or percentage of rainfall immediately running off.

VALUE OF C.—A coefficient corresponding to c has appeared in all the accepted formulas, but as stated in the first part of the paper its value was partially controlled by other considerations than the percentage of rainfall appearing as runoff. As here presented, it has the advantage of being dependent simply on surface conditions, and may be varied according to the engineer's judgment for each case. Its value should not be decided upon without a careful examination of the area and the data required in making the assumption is:

(1) Character of soil. (2) Character of street pavement, including sidewalks. (3) Extent and conditions of lawns and presence of trees. (4) Number of buildings and percentage of area occupied by them. (5) Method of draining their roofs and courts. (6) Such other things, as the presence of parks, exposed ledges or water surfaces, and any natural drainage channels which would probably remain available in spite of future changes. All of these things must be examined with the probable future conditions in mind.

Mr. Kuichling gives the following in his Rochester report, "Report on the East Side Sewer," as the percentage of rainfall appearing as runoff from different classes of surface:

Roofs, 100%; asphalt or stone paving (1st class), 80%; stone paving (2d class), 60%; best macadam paving, 50%; inferior macadam and gravel roads, 40%; yards (lawns, etc.), 20%. From sewer gagings he concluded these percentages to be independent of the value of r. It seems, however, as if all except the first and second might be increased if a previous moderate storm had saturated the soil. Streams from country areas have shown a much larger ratio of runoff to rainfall than 20%, when the conditions of previous soil saturation was present.

No safe rule can now be laid down for the value of c, but proceeding by the foregoing method, the engineer is left to his own judgment of the effect of the conditions met with in each case.

The terms urban, suburban, rural, well built up, etc., are so vague, while an accurate description of an area would have been almost equally void of meaning to one unacquainted with the city described, that we really have very little idea of the conditions indicated by such coefficients as 0.60 (Buerkli-Zeigler), or 0.75 (McMath). To attempt to give average values for the present coefficient would lead to the same confusion and serve no practical end.

It has been attempted to show c as a function of the density of population on the area, but it is hardly possible to find any constant ratio between the two. Comparing the permanent population of a business section having first-class pavements, and the population of a residential section having possibly also first-class pavements, but large lawn spaces, shows how inaccurate a determination so based would be. The area actually contributing the large flow would, according to this method, deserve the smaller coefficient.

The assumption was early made in this discussion that the whole area had a practically uniform slope. If there are two or more distinct slopes it is possible that the steepest one may give a larger flood flow than the total area, in spite of a smaller acreage, owing to the heavier precipitation in the shorter time required for concentration. If such conditions occur, a separate calculation should be made to ascertain the flood flow from the steep area, following the same method as for the total area. Of course, some portion of the flat area would also be contributing at the end of the new t and its flow should be added to that from the steep area.

SIZE OF SEWER.—The value of Q being found by the foregoing method, the calculation of the size of the sewer required to carry such volume on the established grade would then be made by the usual means.

EFFECT OF COST.—If the engineer had concern with the cost of a proposed structure inquiry might be dropped at this point, and ing designed a sewer to carry the maximum the next step would be to build it. But this is a most important point and before deciding building a sewer capable of discharging the maximum flood without backfilling, the possible age which would be caused by an occasional charging of a smaller size must be considered is, of course, a matter of insurance.

Supposing that our records give us data for years, the probable frequency of occurrence some lesser rate for r, corresponding to ½ would be readily ascertained. Assume we find it to be twice in the 15 years; then at compound interest at 4% we would be justified in paying $ in damages, every 7 years, for every dollar saved by constructing a sewer capable of taking the lesser r instead of the greater, and still have the dollar at the end of each period. How far such a percentage of the saving effected would go towards paying damage suits, including costs, would evidently depend upon the use of the buildings occupying the area drained. If the watershed was covered by business blocks in whose cellars were stored goods subject to water damage, this percentage might be plainly inadequate to justify the small sewer. If, on the other hand, the territory was entirely residential, the occasional flooding of cellars would cause no serious damage, providing the soil were such as to drain them quickly when the flood subsided.

Then, also, in choosing c the future condition of the area must be considered, and the best of engineers may go astray on this point If a c be used, which appears safely to cover conditions 20 years hence, and figuring interest at 4%, the city is left in a condition to spend, in enlarging the sewer now built, $2.19 for every dollar saved by building a smaller sewer than would take the flow from a more perfectly developed area. This consideration, of course, applies more directly to suburban districts than to areas where the character of the streets and buildings are already fixed, or which plainly promises great and immediate changes.

It must, however, be evident that a section drained by sewers subject to periodic overflows would feel the effects of such conditions in stagnant or depreciated real estate values, and might in this way cause a real loss to the city.

There are, then, many factors to be considered before reducing the size of the sewer required for the maximum flow, and any apparent economy should be carefully scrutinized before deciding that it is as great as it seems.

STORM SEWERS IN COMBINED SYSTEMS.—Many storm sewers also carry house drainage, but this need not ordinarily be taken into account in providing for the maximum flow. It will, however, be the cause of most of the dry weather flow, and its amount must be considered in deciding upon the cross-section of the proposed sewer, in order that the minimum velocity shall not allow excessive deposits. Artificial flushing in large sewers is practically impossible, and heavy storms will also usually fail to accomplish any effectual cleaning, because of their rarity, and hence the time allowed to form hard, heavy layers on the invert.

While the foregoing method may seem complicated, and, in a sense, indeterminate, it relieves the designer from a blind dependence on formulas whose strict applicability to the drainage area under consideration he may well doubt; it gives him a method of determining a variable value of r, dependent upon shape and slope of the area, and finally, he is able to allot a value to c which will depend entirely upon the surface conditions of that particular area. The amount of money involved in building storm water sewers, and in paying possible damages resulting from overflowing of inadequate sizes, surely justifies the expenditure of the time and thought required to design the sewer according to the method which has been described.

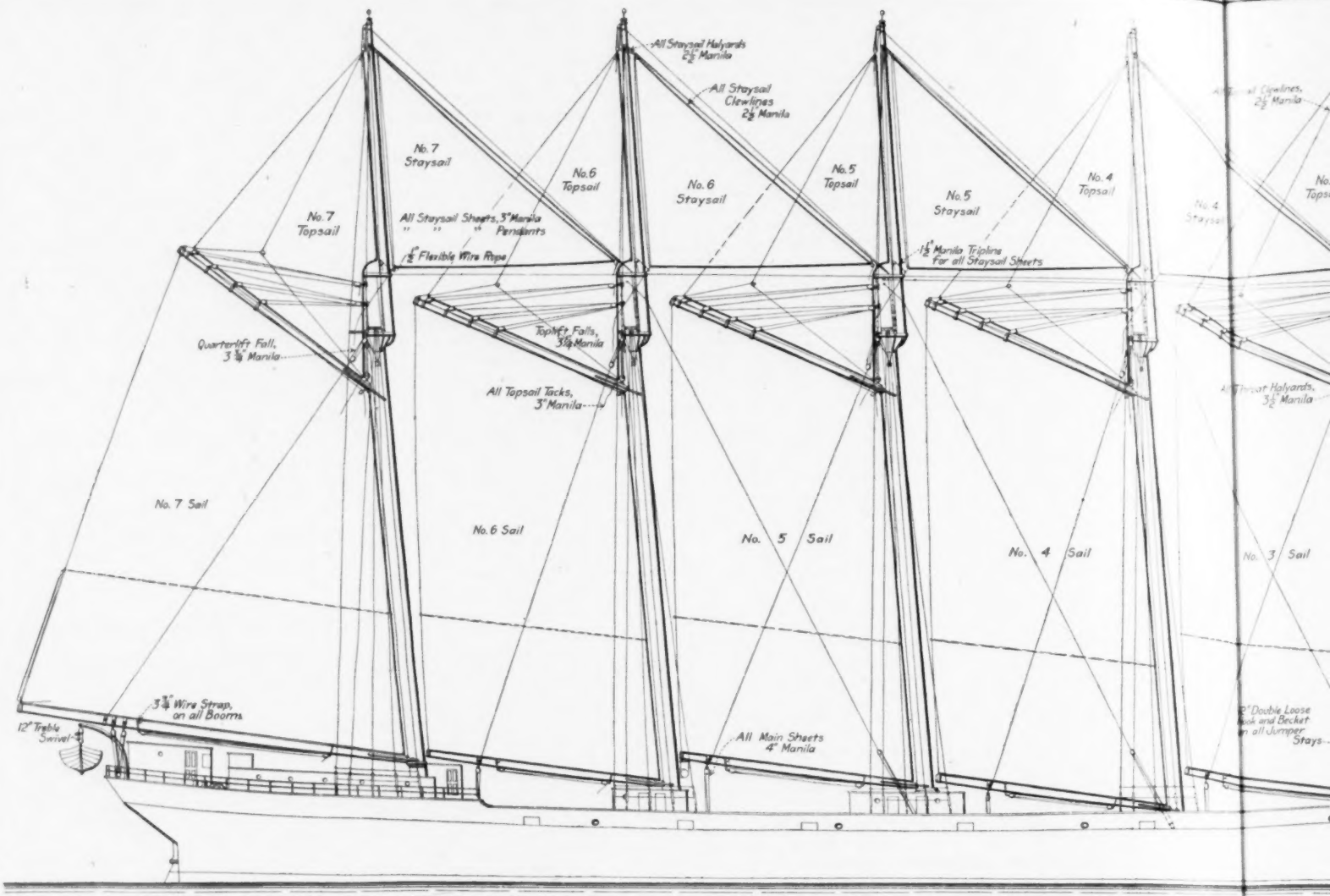
My thanks are due Dr. Daniel Draper, Director of the New York Meteorological Observatory, for permission to use and assistance in examining the rainfall charts of the observatory.

*This formula is the same as Mr. Parmley's with different notation. Professor Talbot has suggested a similar formula, differing only in the addition of a formulation of r, as follows:

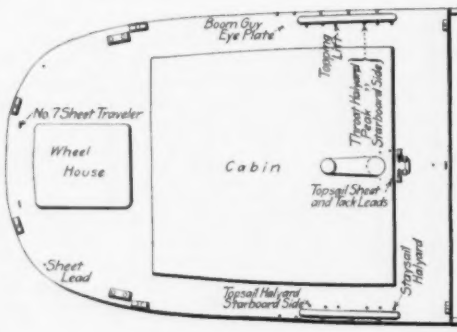
$$\text{Cu. ft. per sec. per acre} = \frac{6{,}300\,f}{\frac{l}{v} + b + 900};$$

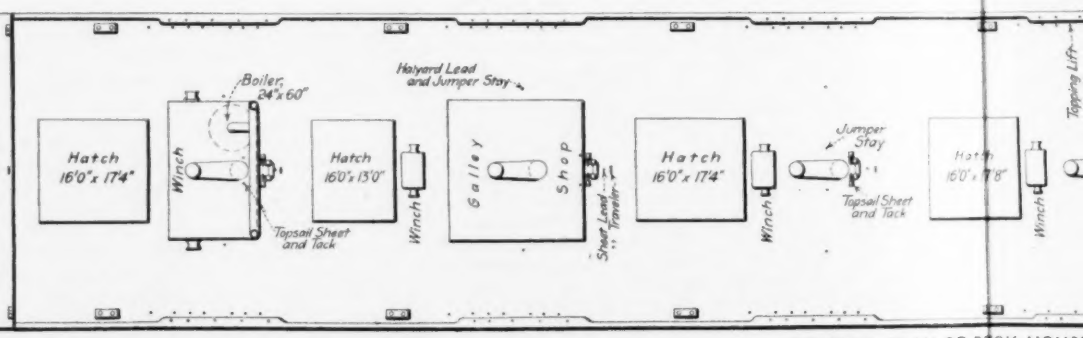
(For ordinary maximum rainfall.)

where
- l = length of sewer in ft.;
- v = velocity in ft. per sec.;
- b = time consumed in traversing surface before entering the sewer in seconds;
- f = percentage of rainfall appearing as run-off.

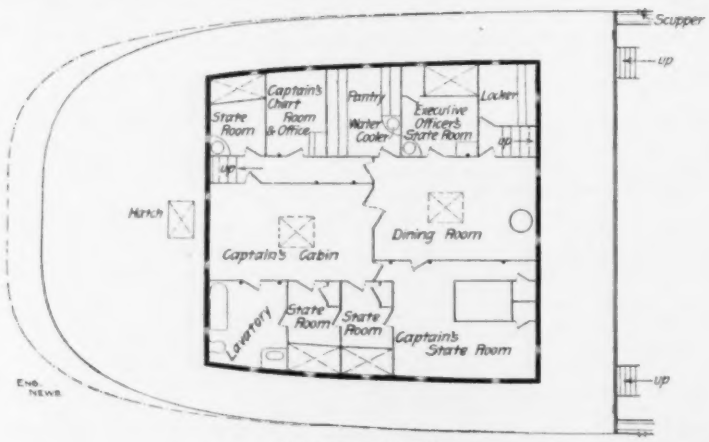


GENERAL ELEVATION SHOWIN





GENERAL PLAN OF DECK HOUS



PLAN AT STERN.

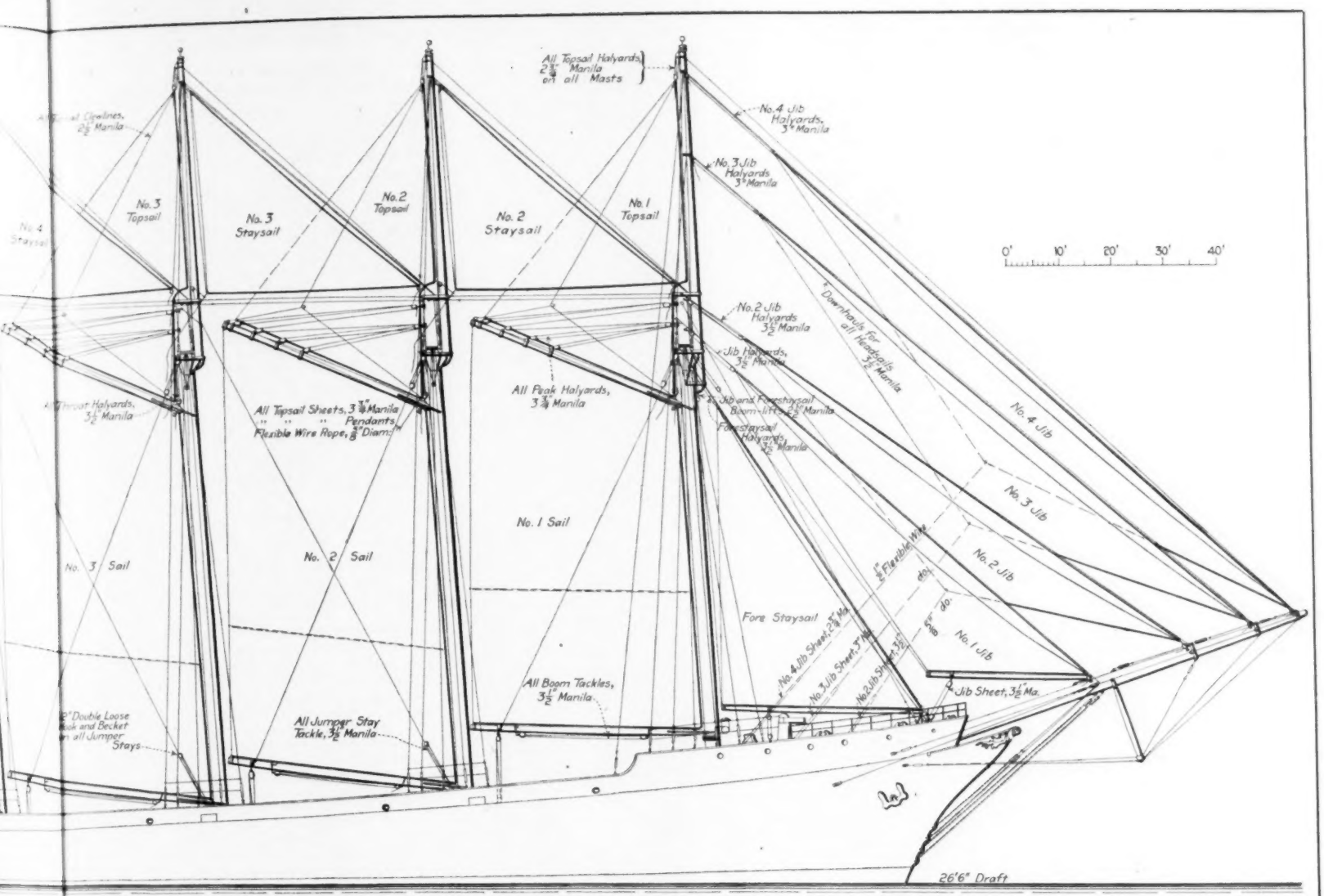
THE SEVEN-MASTED

"THOS. W. LAW

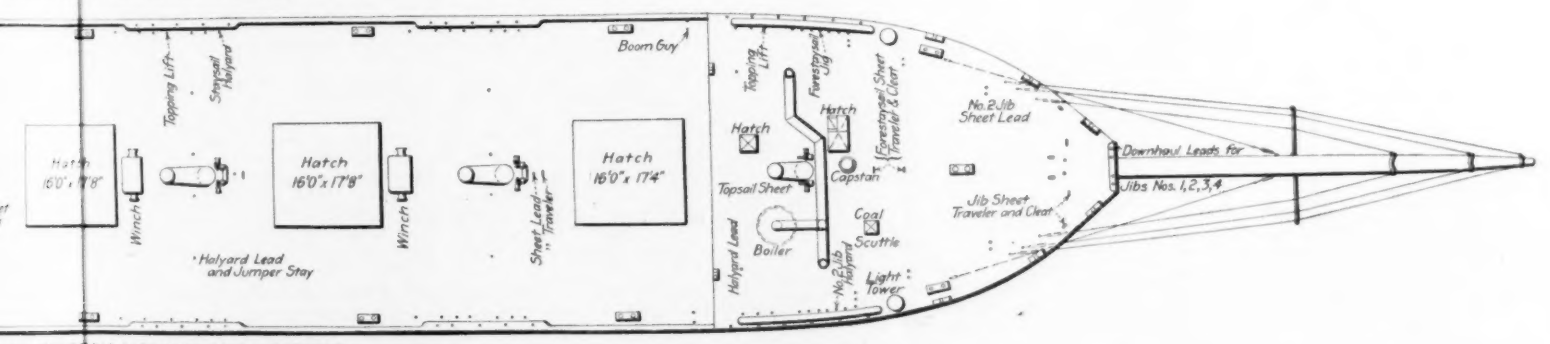
The Fore River Ship &
Qu

Capt. J. G. Crowley, Mar

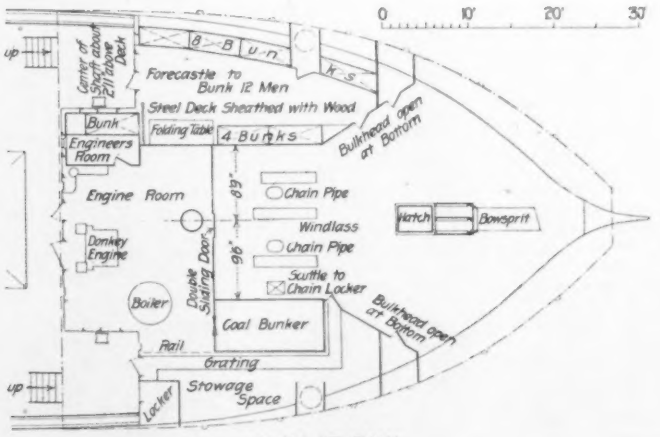
B. B. Crowninshield, Na


All Topsail Halyards, 2¾" Manila on all Masts
No. 4 Jib Halyards, 3" Manila
No. 3 Jib Halyards 3" Manila
No. 3 Topsail
No. 3 Staysail
No. 2 Topsail
No. 2 Staysail
No. 1 Topsail
0' 10' 20' 30' 40'
No. 2 Jib Halyards 3½" Manila
Jib Halyards, 3⅛" Manila
Downhauls for all Headsails 3½" Manila
Jib and Forestaysail Boom-Lifts 2½" Manila
Forestaysail Halyards, 3½" Manila
All Topsail Sheets, 3⅞" Manila
" " " Pendants, Flexible Wire Rope, ⅜" Diam.
All Peak Halyards, 3¾" Manila
No. 4 Jib
No. 3 Jib
No. 2 Jib
No. 1 Jib
No. 1 Sail
No. 2 Sail
No. 3 Sail
Fore Staysail
All Boom Tackles, 3½" Manila
All Jumper Stay Tackle, 3½" Manila
Jib Sheet, 3½ Ma.
26'6" Draft

ELEVATION SHOWING RIGGING.



LAN OF DECK HOUSES AND HATCHES.



PLAN AT BOW.

EVEN-MASTED SCHOONER

"THOS. W. LAWSON"

ore River Ship & Engine Co.

Quincy, Mass., Builders.

G. Crowley, Managing Owner.

rowninshield, Naval Architect.